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ROADS FOR MOTOR TRUCKS

The expedition into Mexico has demonstrated the efficiency of the motor trucks where the roads are of a negligible quality, just as the European war has demonstrated that the motor truck is indispensable in moving and supplying the armies where the roads are good. The saving of Paris is credited to the automobile. While the commercial use of the motor trucks on poor roads or roads not heavy enough for their use will not develop rapidly, they will be used just as often as possible and they will just as inevitably cut the poor roads to pieces. They will be repaired only to be cut to pieces again immediately. The motor truck will, therefore, force the improvement of the roads by means of surfaces heavy enough to stand the strain. The states which have not yet begun the construction of such good roads in earnest will find their repair bills on the old roads mounting so fast that the new surfacing will be necessary as a matter of economy. Nothing short of this pressure will be able to start some communities.

Push the use of the motor truck; push the construction of permanent road surfaces; they will come together. The first will force the second. The second will make the first more rapid.

THE EDUCATION OF THE ENGINEER

What shall be the education to produce the engineer, the definition of whom was discussed last month, is the real question, and as then suggested, every school must train for the majority of the qualifications demanded by the definition. The product of the schools must have the ability to think accurately and consecutively. His natural powers of judgment, "horse sense," in the words of Prof. J. B. Davis, must be given the tools and the training with which to work. And experience indicates that the courses of study followed are not so important as the methods used in following them.

Elmer L. Corthell, the lamented president of the American Society of Civil Engineers, and his contemporary, George S. Morison, who died a few years since, are shining examples of the value of a purely classical education in developing ability to apply innate engineering trends. And while they may be considered engineering geniuses, in a sense, there are many examples among the older engineers of the same kind but less conspicuous, enough to demonstrate the thesis of the committee that a great majority of the engineer's education is not in the line of the acquirement of technical engineering information.

Whether these essential fundamentals of education can be obtained in a purely engineering school has not yet been demonstrated. While few would demand at this time that every engineer should have a fairly complete classical education as a basis for his technical training, the fact remains that the centuries of development of the classical system of education produced a marvelously efficient process of mental training. Unfortunately, modern tinkering with the system is reducing its efficiency. The so-called scientific education, now becoming more strictly technical, has not yet had time to develop equal efficiency in the fundamental training, tho it is making progress in that line. Such inquiries as that of this committee on engineering education show the dissatisfaction of the thinking public with the deficiencies in the education of the engineer and should do much toward finding out how to fill them. Meantime, as much of the old as can be taken as a basis for the new, should be the aim of every young man who has ability and aspirations for the higher walks of the engineering profession.

Two views of the present stage of advancement of technical education toward the ultimate goal of complete education of the all-round-man are given in the discussion of the product of the technical schools by Professors Swain and Mead in *Engineering Record.* The one sees the deficiencies of the present system and its failure to produce the results of the older system of education in inculcating the basic principles of all education, and the other sees the possibilities in the present system of development to include with the technical training the fundamentals of education not now sufficiently developed in that system.

Both the committee and the two professors are discussing the education of real engineers and not that of the men below the average in the schools, too many of whom are actually injured by the attempt made to develop something which is actually non-existent in them.

RESULTS OF FIRST CLEANING WITH SNOW PLOWS.

PROMPT SNOW REMOVAL

IN PHILADELPHIA, PA.

By William H. Connell, Chief of Bureau of Highways and Street Cleaning.

The author of this article is notable for his organizing ability and he gives here the results of his plans for being at all times during the winter in a state of preparedness for the severe contests with snow which, if successful, result in so much comfort to the citizens obliged to be on the streets. When it is possible to obtain such results on the large scale required in a city of the size of Philadelphia, it would seem to be easy to obtain the same results in the smaller cities. The problem is the same but is so much smaller in extent that an intelligent following of the plans here outlined ought to be possible with any competent superintendent of streets.

AN innovation introduced by the Philadelphia Bureau of Highways and Street Cleaning which has been operating successfully for the last three years, is the snow alarm or preparedness in the work of removal of snow. The conception and operation of the "snow alarm" in Philadelphia is one of the unique improvements in the Bureau of Highways which has resulted in greatly benefiting the community. Formerly it was the custom, not only in Philadelphia, but in other cities, to wait until the storm was over before beginning the work of removal. In other words, the city did not begin to dig itself out until after the storm had ceased. As a consequence, the traffic was often very seriously congested.

The main idea in a snow removal organization is "preparedness." At any hour of the night, as soon as the snow starts to fall, the electrical bureau notifies the chief of the bureau and the engineers in charge, by telephone, in their respective homes. One engineer living in the central part of the city is in constant communication with the weather bureau and the chief of the Bureau of Highways and as soon as the indications point to a continuance of the storm, the snow-fighting equipment is ordered out, upwards of one thousand telephone messages being sent to various parts of the city, calling out squad leaders, inspectors, snow plows, drivers, teams, laborers and officers in the various police districts, who aid in getting out the men.

In about one hour after the order is given, the horse-drawn plows and motor-driven plows attack the snow in the central business section of the city. These plows are supplemented by an army of laborers and teams who keep constantly at work day and night shovelling and dumping the snow into sewer manholes and the Delaware and Schuylkill rivers.

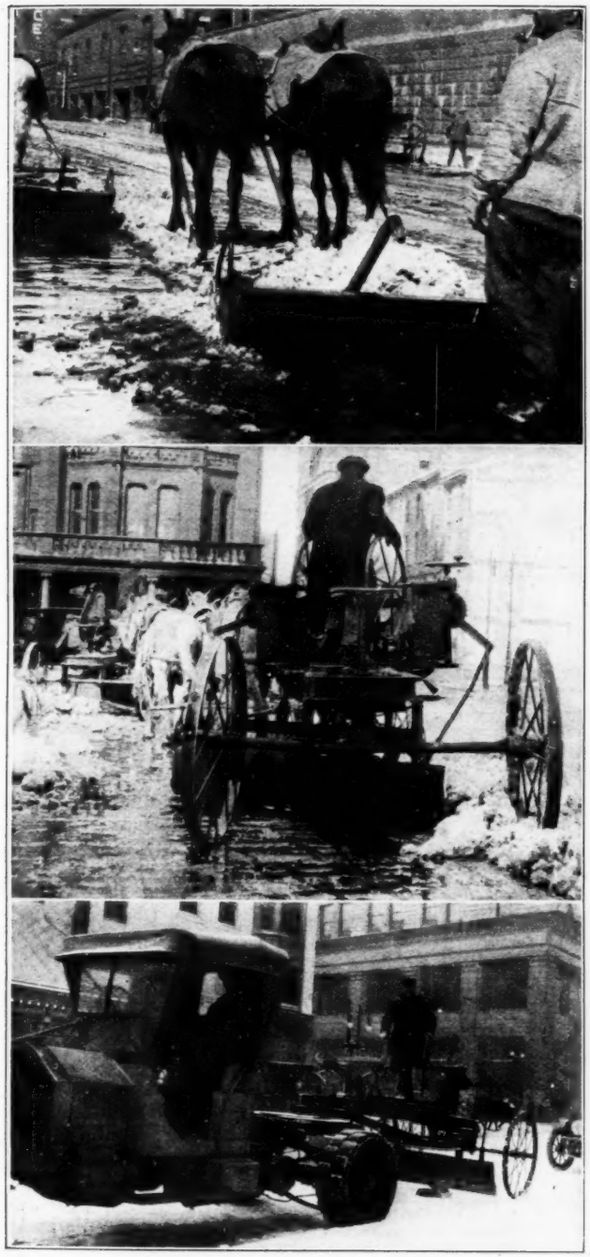
Every man in the snow removal organization has a particular function assigned to him. For instance, each dump inspector knows his post is at a certain dump, and he knows just what to do when he gets there; the driver of every snow plow and every team knows where he is to report, at what point he is to start to load, and at what sewer manhole or wharf he is to dump his loads, and there is no confusion.

Fighting the snow at night during some of the storms we have had in the past three years is no easy task for the Highway Bureau engineers assigned as squad leaders, the inspectors and the laborers, and it requires the constant presence of the chief of the bureau and his principal assistants to encourage the men and stir up the necessary enthusiasm to keep the work going.

In the central business section of the city snow is removed from all the thorofares. This work is performed under special contracts, supplemented by the regular street cleaning force, and is under the supervision of a special snow removal organization made up of men assigned to this work from the regular engineering staff.

Certain main thorofares and all the street crossings thruout the entire city are also cleaned by the regular street cleaning forces and a large municipal force assigned to the seven highway district engineers, who supervise this work. A large force is always employed opening up the country roads, where the drifts often completely block traffic. All told, the force employed on snow removal consists of an army of 4,000 men, 1,200 teams and the advance guard of 38 horse-drawn and 20 motor plows.

Of course, during the daytime the mobilization of the snow-fighting forces is comparatively an easy matter as compared with turning out this force at night, but as the main idea in the Philadelphia snow alarm is simply the practical application



EVOLUTION OF THE SNOW PLOW.

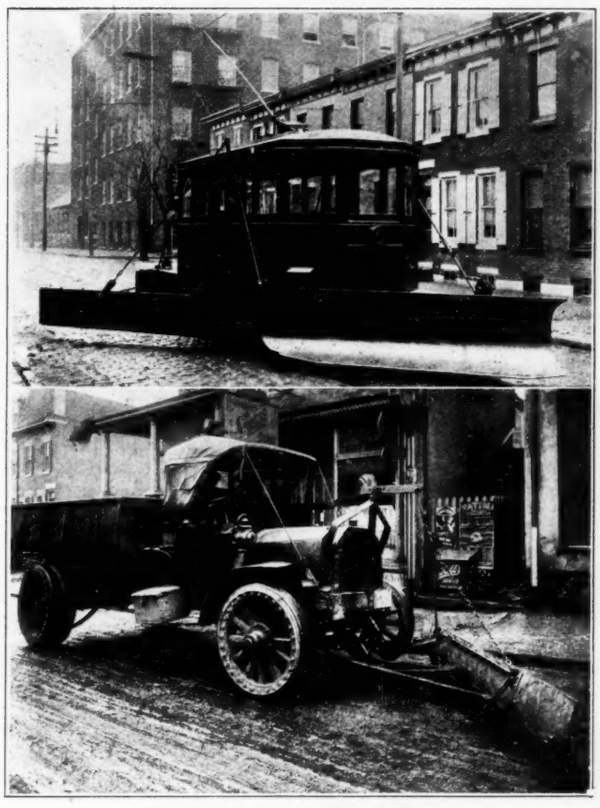
ABOVE: Snow scoops hauled by teams.

MIDDLE: Road graders hauled by teams and used as snow plows.

BELOW: Road grader hauled by motor.

of the principle of preparedness in the work of snow removal, the organization has been instructed in the methods that under the circumstances would seem to be best adapted to prevent interruption to traffic during and after a snowfall. It is a known fact that it is practically impossible to get a great number of laborers to work at night during a very severe storm, and to offset this, great stress has been laid on the use of the snow plows to keep the streets open to traffic. Of course, whenever the storm occurs in the day time or at night when the weather conditions are not too severe, considerable of the work is performed by flushing, sweeping and shovelling the snow into sewer manholes and inlets. This method, however, could not be depended upon in a storm such as the blizzard of February, 1913, as it would be practically impossible to get a sufficient labor force to work to keep the streets open to traffic under such severe conditions as existed the first night of the blizzard, and it is for this reason that we use every effort to keep the plows constantly at work plowing the snow to the side of the street during the progress of the storm. This has enabled us to keep the streets open to traffic when we have had difficulty with the labor situation. We have never had very great difficulty, however, in getting enough laborers and teams in the day time or at night to load the snow piled at the side of the street into the wagons and haul it to the dumps, but we do not depend entirely upon getting sufficient laborers to dispose of the snow by shovelling it into sewer manholes. This feature of the work is simply supplemental to the main feature, which is the use of the plows to keep the streets open to traffic, and after four years' experience with this method, we have concluded to increase the number of snow plows and place the main dependence upon them, as it takes very little time to get them on the work and it is possible to keep them at work at all times, even during the most trying conditions. Of course, when the snow is plowed to the side of the street, it simplifies loading it in wagons for disposal.

Early in the fall of each year, the several division engineers and district assistant engineers are required to prepare a complete assignment schedule for all of the forces under their supervision. This schedule constitutes a program of proposed operations and includes a definite assignment for each individual employe or gang, and indicates in detail the point to which each member of the force is to report and just what duties they are to perform. Prior to the advent of snow, the squad leaders are required to fully acquaint themselves with the traffic conditions existing in their respective snow removal



EVOLUTION OF THE SNOW PLOW.

ABOVE: Street railway snow plow with snow spreader attached.

BELOW: Snow plow mounted on heavy motor truck.

REMOVAL OF SNOW.

ABOVE: By horse-drawn wagons.

BELOW: By motor trucks. Note shovels of men not included by the camera.

districts and with the location and character of the assigned dumping places, the character of and the storage location of the contractors' equipment, and the names and call addresses of both the contractors and the inspectors assigned to their respective squads. They are also required to see that their inspectors and contractors are thoroly instructed in their respective duties, so that there will be no possibility of misunderstanding concerning any detail of the work.

All of the employes assigned to snow removal work understand that they are subject to call at any hour of the day or night, and in case of absence from their scheduled call address, are required to make suitable arrangements for immediately receiving any notice or order to report for duty that may be sent them. Each gang foreman is also made personally responsible for the notification and reporting on the work of a selected number of the regular municipal laborers living in his locality.

To insure the efficient operation of the snow removal work, the following instructions and forms have been provided:

(a) A set of detailed instructions which definitely indicate to the persons supervising the work the nature of the work to be done and the methods to be used in its performance.

DUMPING AND SHOVELING SNOW INTO SEWER MANHOLE.

(b) A map indicating the highways included in each of the nineteen central snow removal districts and the nature and exact location of the snow dumps.

(c) An organization schedule indicating the name and call address and telephone number, and the assignment of each person detailed to snow removal supervision.

(d) Tickets of distinctive colors for loading and dumping respectively.

(e) Ticket issue records.

(f) Current status of work records.

	SNOW REMOVAL LOADING TICKET		BUREAU OF HIGHWAYS AND STREET CLEANING	SNOW REMOVAL LOADING TICKET			
	DISTRICT	TICKET No.	DEPARTMENT OF PUBLIC WORKS	DISTRICT	TICKET No.	DATE	
			CITY OF PHILADELPHIA				
	THE TICKET CORRESPONDING TO THIS STUB WAS ISSUED ON (DATE) _____ 191		TO INSPECTOR AT DUMPING STATION: ALLOW BEARER TO DUMP AT PROPER STATION ONE LOAD OF SNOW OF THE CAPACITY INDICATED AND EXCHANGE THIS TICKET FOR DUMPING TICKET NUMBER _____ FOR AN EQUIVALENT CAPACITY			INSPECTOR	CAPACITY OF LOAD IN CUBIC YARDS

	SNOW REMOVAL DUMPING TICKET		BUREAU OF HIGHWAYS AND STREET CLEANING	SNOW REMOVAL DUMPING TICKET			
	DISTRICT	TICKET No.	DEPARTMENT OF PUBLIC WORKS	DISTRICT	TICKET No.	DATE	
			CITY OF PHILADELPHIA				
	THE TICKET CORRESPONDING TO THIS STUB WAS ISSUED ON (DATE) _____ 191		THIS CERTIFIES: THAT ONE LOAD OF SNOW OF THE INDICATED CAPACITY WAS DUMPED AT PROPER STATION, AND THAT THIS TICKET WAS EXCHANGED FOR LOADING TICKET NUMBER _____			INSPECTOR	CAPACITY OF LOAD IN CUBIC YARDS

BUREAU OF HIGHWAYS DEPARTMENT OF PUBLIC WORKS CITY OF PHILADELPHIA	TICKET ISSUE RECORD FOR SNOW REMOVAL WORK	STORM DATES: TICKETS ISSUED BY:

DISTRICT	KIND OF TICKETS	SERIAL NUMBERS OF TICKETS ISSUED												SIGNATURE OF RECIPIENT
		FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	
1	LOADING													
	DUMPING													
2	LOADING													
	DUMPING													
ETC.	LOADING													

TOP: Ticket given driver when he leaves the street with a load.

MIDDLE: Ticket exchanged for the above when load is dumped.

BOTTOM: Heading of record sheet keeping account of all tickets issued, both for loading and for dumping.

BUREAU OF HIGHWAYS AND STREET CLEANING
DEPARTMENT OF PUBLIC WORKS
CITY OF PHILADELPHIA

SQUAD LEADER'S DAILY REPORT ON SNOW REMOVAL WORK

DISTRICT No.
DIVISION No.

PLOWING FORCES / REMOVAL FORCES	ORDERED TO REPORT FOR DUTY	A.M. / P.M. / A.M. / P.M.	REPORTED ON THE WORK	A.M. / P.M. / A.M. / P.M.	NUMBER OF TICKETS ISSUED	LOADING	DUMPING

WORK PERFORMED ON THIS DATE

CHARACTER	ON	FROM	TO	QUANTITY LOADS	QUANTITY CUBIC YARDS

FORCE EMPLOYED ON THIS DATE				INSPECTORS				
LABOR AND EQUIPMENT	NUMBER	HOURS WORKED	HOURS IDLE	NAME	ASSIGNMENT	STARTED	STOPPED	HOURS
FOREMEN								
LABORERS								
HORSE-PLOW OUTFITS								
HORSE-SCRAPER OUTFITS								
MOTOR-PLOW OUTFITS								
DOUBLE TEAMS								
MOTOR TRUCKS								

CONTRACTOR: NAME

WEATHER CONDITIONS — TEMPERATURE: MINIMUM — MAXIMUM

DELAYS: REASON AND DURATION

INSTRUCTIONS RECEIVED FROM ASSISTANT ENGINEER:

TIMES OF YOUR REPORTING ON THIS WORK — COMMENCEMENT — COMPLETION

REMARKS:

DATE OF THIS REPORT ---------- 191 — SUBMITTED BY ---------- SQUAD LEADER — APPROVED BY ---------- DIVISION ENGINEER

(g) Squad leaders' daily reports.

(h) Squad leaders' daily report summary.

The central business section is divided into nineteen districts, each district being under the supervision of a squad leader, to whom is assigned a number of inspectors, some of whom supervise the removal of the snow, while others see that it is properly disposed of at the dumping places. The inspectors supervising the snow removal see that the snow is properly plowed into windrows adjacent to the curb, and then piled out and hauled to the dump. They are also required to measure and calculate the cubical capacity of all hauling vehicles and see that these vehicles are properly loaded, after which they give the drivers loading tickets, which are exchanged at the dump for another ticket which is retained by the driver, and upon which payment is made.

The inspectors at the dumping places are required to see that the snow is properly dumped and that no improper material likely to obstruct the sewer is mixed with the snow. In the sewers where there is not a sufficient flow of water, a water jet has been provided, which serves to increase the flow in the sewer and this is regulated by the inspector.

All inspectors on both the loading and dumping work are required to see that the work is performed in such manner as to entail the least possible interruption to traffic.

After the beginning of operations, each squad leader makes hourly reports to the main office of the force of labor and equipment on the work, and also of the general conditions existing in his respective district. These reports are entered on the current status of work record, which greatly assists in the administration of the work.

Each squad leader is also required to make a daily report which indicates in detail the character and quantity of the work performed, the force employed and other appurtenant details.

The highly satisfactory results produced thru the operation of the snow-fighting forces under this system in the past several years has proven conclusively that the efficient administration of snow removal work is fundamentally a matter of preparedness based upon an exhaustive study of the requirements of the work and the establishment of a proper organization; the provision of a definite and adequate procedure, and the thoro instruction and drilling of the snow-fighting forces in the requirements of their respective duties.

BUREAU OF HIGHWAYS AND STREET CLEANING
DEPARTMENT OF PUBLIC WORKS
CITY OF PHILADELPHIA

CURRENT STATUS RECORD OF SNOW REMOVAL OPERATIONS

DISTRICT No.
DIVISION No.

REPORTED AT	FORCE AT WORK: LABOR		EQUIPMENT					PROGRESS AND CONDITIONS	REPORTED BY
DATE	TIME	FOREMEN	LABORERS	HORSE-PLOW OUTFITS	HORSE-SCRAPER OUTFITS	MOTOR-PLOW OUTFITS	DOUBLE TEAMS	MOTOR TRUCKS		

BUREAU OF HIGHWAYS
DEPARTMENT OF PUBLIC WORKS
CITY OF PHILADELPHIA

SUMMARY OF SQUAD LEADERS DAILY REPORTS ON SNOW REMOVAL WORK

DISTRICT No. — DIVISION No. — STORM DATES — REMOVAL DATES

DATES OF WORK IN PROGRESS	FORCE EMPLOYED: FOREMEN	LABORERS	EQUIPMENT EMPLOYED: HORSE-PLOW OUTFITS	HORSE-SCRAPER OUTFITS	MOTOR-PLOW OUTFITS	DOUBLE TEAMS	MOTOR TRUCKS	SNOW REMOVED: LOADS	CUBIC YARDS
TOTALS									
FURNISHED BY CONTRACTOR: UNIT									
FURNISHED BY CONTRACTOR: TOTAL									
FURNISHED BY CITY FORCES: UNIT									
FURNISHED BY CITY FORCES: TOTAL									

TOTAL QUANTITY IN CUBIC YARDS OF SNOW REMOVED		TOTAL COST	CONTRACT ESTIMATED		UNIT COST	CONTRACT ESTIMATED	

PLANNING BOARD
OFFICE OF ASSISTANT ENGINEER IN CHARGE OF SNOW REMOVAL WORK

GRAPHIC PROGRESS RECORD USED IN CONNECTION WITH SNOW REMOVAL MAP

BUREAU OF HIGHWAYS AND STREET CLEANING
DEPARTMENT OF PUBLIC WORKS
CITY OF PHILADELPHIA

CHARACTER OF EQUIPMENT AND LABOR	CURRENT CONDITIONS	SNOW REMOVAL DISTRICTS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
MOTOR PLOWS	NUMERICAL STRENGTH	
	INSPECTOR AT PLANT	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
HORSE-DRAWN PLOWS	NUMERICAL STRENGTH	
	INSPECTOR AT PLANT	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
MOTOR TRUCKS	NUMERICAL STRENGTH	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDER TO SUSPEND WORK	
TEAMS	NUMERICAL STRENGTH	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
EMERGENCY SNOW REMOVAL FORCES	NUMERICAL STRENGTH	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
REGULAR STREET CLEANING FORCES	NUMERICAL STRENGTH	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
MUNICIPAL MAINTENANCE FORCES	NUMERICAL STRENGTH	
	READY FOR WORK	
	ORDERED TO WORK	
	BEGAN WORK	
	ORDERED TO SUSPEND WORK	
INSPECTORS	NUMERICAL STRENGTH	

THREE RECORDS OF SNOW REMOVAL.

ABOVE: The continuous record of conditions on the street, kept up to the minute while snow removal work is going on.

MIDDLE: Summary of squad leaders' daily reports.

BELOW: The Planning Board in the office of the assistant engineer in charge of snow removal work, used in connection with a city map with the districts defined on it and tacks of different colors and designs to designate the classes of apparatus and men engaged and places where they are at work.

BUILDING CONCRETE ROADS

IN LAKE COUNTY, OHIO

By Homer P. Cumings, County Engineer, Painesville, Ohio.

A practical article, unusual because it gives an account of some failures to obtain the best results, explains the reasons for them, and shows how the mistakes were corrected in later designs and construction. The article is therefore of much value to contractors and to engineers and will well repay careful study. It is by the engineer in charge of the work and responsible for all the designs except those for the pavements under construction when he took the office of County Engineer. The paper was read before the Ohio Engineering Society.

THE first concrete road in Lake county, Ohio, was built in the summer of 1912 under state specifications and state supervision, leading south from the village of Madison 1.41 miles long, width 12 feet, thickness of concrete 6 inches, cross-slope 2 inches. The pavement was laid to one side of the center of the road with an earth road alongside. Width of berm on outer side of pavement, 4 feet. Drainage was provided for by open ditches on either side, 2 feet in depth. The road has a sufficient longitudinal grade at all points to insure a ready flow of water in the ditches. The soil is a heavy clay. It was reported to be the worst soil in Lake county to heave. I was placed in charge of this work when the construction was more than half completed. Well do I remember the first day that I went onto the job. The contractor was present in person and I believe he was trying to build a good road. The concrete was being mixed by hand on a wood platform or by a mixer that was not intended for road work, according to whether the hands or the mixer seemed to be in the best working condition that day. A good quality hard blue limestone running up to about 2 inches in size was used as the coarse aggregate. The fine aggregate was lake sand hauled by teams from the lake, 6 miles away. It was a one-course job and the mix specified was 1:1½:3½. The surface was finished with a wood float and after the entire 1.41 miles were completed it was cleaned as thoroly as possible and given a surface treatment of tar. The cleaning process was no joke, as the pavement had been covered with clay to aid in curing, and a considerable portion of it had been traveled over for several weeks. Steel brooms, reed brooms and barn brooms were used, and we hoped that what clay didn't come off would be absorbed. Perhaps this was the case for over the greater part of this pavement the tar stuck well. Over a stretch of several hundred feet in one location it peeled off badly the first winter, without any reason that I was able to discover. This was repaired the following spring and has since stood as well as the other portions. This pavement was laid in blocks 30 feet in length. When I looked at it on the occasion of my first visit to the job and thought of what that clay did when the frost went out in the spring, I asked the contractor if he didn't expect the pavement would break all up in the spring. His reply was, "Oh, I guess not." And it has not. A considerable portion of the tar surface (less than half) has disappeared, going off in small patches and leaving the pavement with a mottled appearance. The surface of the concrete where the tar has disappeared is showing no marked amount of wear. A few cracks have appeared, perhaps half a dozen would come close to covering the number. The pavement is in good condition, and is the pavement that convinced me that concrete can be laid on a clay soil and not break up from the effects of freezing and thawing. The contract price of this pavement was $11,970. The contractor assures me, however, that those figures do not indicate what the pavement actually cost.

The second concrete pavement was laid in the summer of 1913, on the Weeds Corner Extension Road. This pavement is 2.21 miles in length, 12 feet in width and 6 inches thick. It was built under state specifications and is a two-course job. The cost was about $25,000. The soil is clay. Drainage is provided for by open ditches. The specifications read "foundation course shall consist of 1:2½:5 concrete 4 inches in depth; top course shall consist of a 1:1½:3 concrete 2 inches in depth." The coarse aggregate for the base was to be graded in size from ¼ inch to 1½ inch, and for the top from ¼ to 1 inch. This pavement was in fact built with a local creek gravel as the coarse aggregate for the base. This gravel was of a very fair quality and conformed quite well with the requirements of the specifications. The fine aggregate was a creek sand from the same location as the gravel. and showed up exceptionally well in the tests to which it was subjected. The coarse aggregate for the top was obtained by crushing boulders collected from the nearby fields. A large per cent. of these boulders were granite and supplied a crushed rock of very good quality. There were, however, among them some of a soft or dead quality, the nature of which often could not be detected until they were crushed and then it was too late to keep them out of the mass of stone used. This, we believe, to account for the fact that numerous holes have formed in the surface of certain parts of this pavement, pockets of this soft rock having given way under traffic. The surface of this pavement was finished with a wood float and with a light cross stroke with a coarse brush. Before the concrete was opened to traffic, the surface was thoroly broomed with steel brushes and a coating of tar and granite screenings, applied. When the supply of screenings from the crusher plant was exhausted, the remainder of the surface was covered with fine silica gravel. The screenings seemed to give the more satisfactory surface. This tar coating, however, has not proven satisfactory. It began peeling off badly the first season after being completed and today about one-half of the surface is bare. This pavement has had a considerable amount of heavy traffic. Three blocks have broken badly, due to settlement of a fill. Considerable cracking has occurred, about 100 blocks being broken out of a total of 390. Some displacement has taken place at joints, due, I think, chiefly to settlement of blocks. All of the material used in a 1.34 mile extension of this pavement was hauled over it in automobile trucks in the summer of 1914. Quite extensive repairs to the surface of this pavement are scheduled for the coming summer.

In the summer of 1914 an extension of this pavement was built. This extension was 1.34 miles in length and was similar in every way to the one just described, except that the top course was a 1:1:2 concrete; slag was used for the coarse aggregate in the base and silica gravel in the top for about one-half of the job and hard limestone in the top for the remainder. No tar was used on the surface of this pavement. The surface is today in almost perfect condition, but a considerable amount of cracking has taken place, about 100 blocks being broken. A very close examination is required to detect the difference in

the surface where the silica gravel was used and where the limestone was used. Both are in equally good condition and hardly a flaw can be detected except the cracks. The contract price of this work was $17,115. In both of the last two described pavements the cracks are about equally divided between longitudinal cracks and transverse cracks, but in either case, nearly all occur in the middle one-third of the block.

Also, in the summer of 1914, 9.8 miles of county road were built in the township of Madison, under two contracts, one for 5.43 miles on the Madison South Ridge Road and one for 4.37 miles on the Lake-River Road. The South Ridge Road, as its name indicates, is laid on the southerly one of three natural sandy ridges running in an easterly and westerly direction thru this part of the county and very nearly paralleling the south shore of Lake Erie. While this ridge is for the most part of a sandy and gravelly nature, yet numerous springy and treacherous spots occur in it, so that while it was a deep sand bed for traffic in the summer, it offered many mire holes in the wet season. The longitudinal grades on the greater portion of this road are light. Drainage was provided for by open ditches, 1½ feet deep, by storm water sewers with numerous inlets and by tile drains discharging into the inlet basins. A street car track lies along one side of this road for about one-half its length. A 4-inch tile drain was laid the entire length of this track in the center of the strip between the track and pavement and 30 inches below the surface of the pavement.

This pavement is 16 feet wide, 6 inches thick at the edges and 7 inches thick in the center, the surface having a crown of 1½ inches. This is a one-course pavement, the proportions of cement, fine aggregate and coarse aggregate being 1:2:3½.

The fine aggregate was a dredged lake sand. Our only difficulty in keeping this sand up to requirements was to get sand that was sufficiently coarse and it was necessary to reject a number of carloads on this score. The coarse aggregate was the very hard, round, smooth pebble which we know as silica gravel. The condition of this pavement at the present time would indicate that a concrete built with this pebble offers a wearing surface almost indestructible under the abrasive wear of ordinary traffic, but also gives a body lacking in tensile strength. The surface of this pavement is as handsome a specimen of road surface as one could wish to see, with hardly a defect in it, except for the cracks. It doesn't seem to know where to stop cracking, except when it comes to a block that was reinforced. Then it usually stops. Some ninety blocks were reinforced with American Steel and Wire Co.'s triangle mesh No. 28. These blocks were in wet or springy places or on fills or where sewer trenches had been excavated. Out of these ninety blocks about a half dozen have fine cracks. These have not opened up so as to cause any damage whatever. You can follow a longitudinal crack down the center of this pavement block after block till it comes to a block that was reinforced because of a sewer trench. This block will be perfectly sound and the crack will begin again on the other side. In one section seventeen blocks were reinforced because of a fill of from 1 foot to 4 feet in depth. Not a crack has appeared in any of these blocks. In passing thru the business section of Madison village this road was paved from 40 to 45 feet in width. These blocks are all reinforced. Only a few cracks have appeared and none of these have opened up. One has to look closely to discover them. The blocks in this pavement are 33 1/3 feet in length. A few transverse cracks have appeared, but the most of the cracks are longitudinal. These cracks nearly all appear in the middle one-third of the block. Tho the number of cracks in this pavement is very great, but very few of them have as yet opened up so as to do any damage whatever to the pavement. The great majority of them are mere hair lines.

The first half mile of this pavement was laid with ⅜-inch expansion strips at the joints, with no armor plates. The edges of the blocks at these joints have rounded off, but the ravelling has increased but very little since the first few months of traffic. After the first half mile was laid all joints were armored with Kahn plates. These joints are in practically perfect condition except where the concrete was left too high and floated over the plates, in which cases the edges of the blocks have rounded down to the plates. Very little, if any, chipping back of the plates has occurred.

The cost of this road was $97,909.37, which I have divided into four general groups as follows: Grading, $11,465.50; drainage, $13,082.17; pavement, $71.738.26; masonry and culvert repairs, $1,623.44. Notwithstanding the one defect of numerous cracks in this pavement, I believe it will give long and satisfactory service with a very small cost for maintenance.

The Lake-River Road runs in a north and south direction and extends from Lake Erie on the north to Grand River on the south. The part of this road that was paved is a section 1 mile in length. running south from the South Ridge Road at Madison village and a section 3½ miles in length running north from said village. The greater part of the south mile is on clay soil. The north 3½ miles are on a lighter and more sandy soil with numerous wet and quick-sandy places. The first mile north from the village has always been an exceptionally difficult piece of road to keep in a passable condition. A longitudinal grade sufficient for good drainage exists on nearly the entire length of this 4½ miles. This pavement was built under the same specifications as the South Ridge pavement. The width and depth of concrete were the same, and about a proportionate amount of tile drainage and sewer work were done. A good quality of well-graded washed gravel was used for the coarse aggregate. This gravel ran somewhat coarser in size than the silica gravel used on the South Ridge and the pebbles were not so smooth and glassy in surface. The sand used in the first mile either way from the village was from the same source as the sand used on the South Ridge, while the sand used in the north 2½ miles was from a local pit. This pit sand was of excellent quality, but was too fine to be entirely satisfactory. The same difficulties in securing a sufficiently coarse sand were experienced in the early shipments for this road as noted on the South Ridge Road. Some of this defective sand got into the first mile of pavement north of the railroad at Madison and we believe is partially responsible for certain defects that have appeared in this mile of work. This was the first section built on this road. As soon as the last block laid was three weeks old, hauling over it of material for the 2½ miles north of it was begun. At numerous places in this mile of pavement, the surface has worn down under traffic, showing depressions at these spots of usually from ½ to 1 inch. The most of this wear seems to have occurred during the first few months after the pavement was opened to traffic, very little additional wear having occurred at these places during the past summer. We believe some of these defects to be due to poor sand, but a greater cause to be the breaking of the bond in the surface of the concrete by too heavy traffic before the concrete was old enough to withstand this traffic. I have observed that a traction engine with lugs on the wheels which would chip the pavement in passing over it the first season after it was opened to traffic, will now pass over it without leaving a mark, showing conclusively that the pavement is not at its best for a long time after it is laid and that traffic should be kept off from it as long as a long-suffering public can be made to suffer. Except for this 1 mile, the surface of the pavement on the Lake-River Road is practically as perfect so far as abrasive wear is concerned as the day it was opened to traffic. The pavement has cracked to a considerable extent, tho not nearly as much as the silica gravel concrete on the South Ridge Road. Yet where cracks have occurred they have opened up and damaged the

pavement to a far greater extent than is the case on the South Ridge.

The cost of this road was $72,841.07, divided into the four groups, as follows: Grading, $5,992.04; drainage, $10,354.45; pavement, $56,430.58; masonry, $64.00.

As on the other road, the length of the blocks was 33 1/3 feet. Except for the first half mile laid, all joints were protected with Kahn plates, a ⅜-inch expansion strip being placed between the plates. These joints are in practically perfect condition today. At some of the wet and treacherous places, blocks were reinforced with rib metal reinforcement size No. 6 as manufactured by The Trussed Concrete Steel Company. In all, nineteen blocks were so reinforced. Not one of these blocks shows any crack or defect of any kind.

Our experience with the Madison pavements, not only in the matter of the cracking of the concrete, but also because of difficulties we experienced in securing a uniform grade of gravel for a coarse aggregate, determined us to use only a crushed rock for the coarse aggregate in the next concrete pavement to be built in Lake county, and also determine us to reinforce all concrete pavements hereafter built. Following out this decision, contracts were let in the spring of 1915 for paving with concrete three roads in the township of Perry, aggregating 9.73 miles as follows: The Perry South Ridge Road, 5.12 miles, which is an extension westerly of the Madison South Ridge Road; The Narrows-Center Road, 2.38 miles, a road running northwesterly from the South Ridge Road and passing thru the village of Perry, and the Call Road, 2.23 miles, running northeasterly from The Narrows Road.

The first two of the above named roads were completed during the past season. The concrete pavement is 16 feet wide, 6 inches thick at the edges and 7½ inches thick in the center, the surface having a crown of 1½ inches. Soil conditions were similar to those in the Madison work and the same attention was given to drainage as on that work. The concrete was laid in two courses, the base being 4 inches thick at the edges and 5 inches thick at the center. The top course is 2 inches thick at the edges and 2½ inches thick at the center. A 1:2½:4 concrete was used in the base, the coarse aggregate being a hard limestone; the top is a 1:1½:2½ concrete, the coarse aggregate being trap rock, graded in size from ¼ inch to 1¼ inches. The blocks are 33 1/3 feet in length. Joints are armored with Kahn plates separated with ⅜-inch expansion strips. Every block is reinforced with Kahn road mesh No. 25, placed in the upper part of the base course. The sand used in the greater part of this work was from a local pit and tests made upon it from time to time showed it to be of excellent quality and well graded.

One of the novel features in the construction of the work was in the use of bulk cement. With the exception of the first mile or so of the work on the South Ridge, all cement for this work was shipped in bulk. This was handled in the following manner: Cement-tight wagon boxes were used. These were placed so that top of box would be level with car floor. An 8-foot coal chute was then hooked onto the planking across the car door opening, with the end resting in the wagon box. The cement is then shoveled into the chute until the car is cleared from door to door over a space about the width of the door opening. After this opening is made in the car, a low-hung, open-end cart is used, the body of which holds five sacks of cement. One man handles the cart, loading it by driving the open end into the cement and completing the filling with about three strokes of a winged hoe. He then wheels it to the wagon over a platform spanning the opening between car and wagon, and dumps it. On the line of the work, six boxes are used for receiving the cement. These boxes are fitted with a movable ridge pole to support a canvas cover which thoroly protects the cement from storm. The cement is shoveled from the wagon into coal chutes hooked over the wagon box with the end resting in the receiving box. Each box is filled to a fixed point which furnishes just enough cement for a given length of pavement. The cement is shoveled upon the receiving boxes into measured wheel barrows and wheeled to the mixer.

The handling of cement in bulk proved very satisfactory. There was less waste than with sacks. Absolutely no cement was damaged by storms. The inspector could check the amount of cement used more easily than with sacks. And the contractor had no sacks to bother with and no money tied up in sacks.

Another matter that interested us considerably was an experience early in the season when bulk cement was being used at the east end of the road and sacked cement at the west end of the road. The stone and sand were the same on both jobs. The bulk cement and the sacked cement had shown about the same results in the tests that had been made. Both cements had developed some heat in the car but had tested out all right. Both were from the same company and shipped at the same time. Yet with several days in succession of very drying weather, considerable difficulty was experienced in preventing checking of the surface, as the concrete began setting up on the job where the sacked cement was being used, while very little difficulty of this kind occurred on the job where the bulk cement was being used. Did the three times that the bulk cement had been shoveled over have anything to do with it?

The cost of these pavements was as follows: The South Ridge Road, $80,226.20, with the following division among the four groups: Grading, $6,275.10; drainage, $6,529.06; pavement, $67,077.34; masonry, $344.70. The Narrows-Center Road cost $42,718.94, divided as follows: Grading, $4,053.27; drainage, $5,925.67; pavement, $32,590.00; masonry, $150.00.

These pavements are now going thru their first winter. It is, of course, too early to be able to say what they will eventually show. Yet they have already passed thru four periods of moderate freezing, one period reaching to about the zero point, followed each time by a sudden thaw and complete break up. Up to the present time, I have not been able to discover one crack or defect of any kind in the entire 7.5 miles, tho I have made several careful inspection trips over them. Neither has anyone reported any crack or defect to me.

Out of six roads herein described, each somewhat different in its construction from the other, we have pinned our faith to the Perry construction.

A concrete pavement, to be worth while, must be constructed with first-class workmanship and first-class material. Nothing less will do. But past experience and experiments indicate that, with these two ingredients, the concrete pavement will make for itself in the coming years, a worthy record.

About 20 miles of pavement were under contract in 1915. In 1916 about 14 miles of road will be paved with brick and concrete, mostly the latter. Very careful supervision is given to all our work, both by the engineers and by regular inspectors, who are continuously on the job, yet our engineering and inspection usually amount to about 3 per cent., never over 4 per cent.

Full Meterage of Water Supply

AT MILES CITY, MONTANA.

By G. C. Pruett, City Engineer.

DOES it pay to install water meters, is a question which is receiving at the present time more attention, perhaps, than any other in the water works field; and justly so, because of its importance.

First, by installing meters it is possible to forestall extensive improvements and extensions to the plant by reason of the reduced consumption following a general meter installation.

Second, it places all consumers on an equitable and comparable basis.

No other business would consider for a moment the sale of its product except on a measured or unit basis, and the reason for not doing so in the case of water, where it is possible to meter, is certainly not explainable.

Where water is pumped, as it is in most instances, or where it is piped thru expensive conduits from costly supplies at some distant source, the cost of installing meters can generally be saved many times over on the cost of the original installation. Not only this, but the cost of maintenance will in most, and I believe in all cases, be less than the extra cost of maintenance and operation of the plant installed without considering the use of meters, not even taking into consideration the extra interest, depreciation and reserve necessary for the larger and more expensive plant.

I have found in my experience at Niles City, Montana, first with a flat rate plant and later with one 100 percent metered, that, after getting the meters installed, the general satisfaction from the customers is greater than it was on the flat rate basis.

First of all, ours is a municipally-owned plant, and by constantly keeping this matter before the community, the citizens have come to regard the plant as belonging to them, and realize that all additional expense caused in operating the plant must necessarily be borne by them. They have, therefore, welcomed the introduction of meters, for by doing so they know that every person using water is placed on the same equitable basis, and that the water hog will pay his proportionate share of the expense.

The matter of installing meters first came up in Miles City in 1911, but not having been sufficiently explained, it met with some objection, and the ordinance authorizing the installation of meters was served with a referendum notice which required that it be submitted to a vote. The election was held in the early part of 1912, and, needless to say, carried by a good majority; in fact, by a vote of 3 to 1.

The original intention under the ordinance was to begin metering gradually, getting first those using the greatest amount of water without a proportionately higher rate, and those who intentionally or carelessly wasted it, with a further provision that anyone else desiring it could have a meter installed by making application to the superintendent. After a number of installations on consumers known to be using a greater amount of water than they were paying for, and who naturally objected, and a few on application, I found that applications came in so fast that I could not take care of them. At the end of two months not less than 75 percent of our consumers had made application for meter service.

The meters were furnished and installed by the city without cost to the consumer except in cases requiring the rearranging of pipes, the cost of which was charged to the consumer at cost. I have found, here and elsewhere that the only practical way is for the utility to furnish, instal and maintain the meters, with proper regulations as to damage caused to the meter by neglect or carelessness on the part of the consumer. By this method the utility has proper control over the meters at all times, without going thru a lot of preliminaries, as would be the case with privately owned meters. The utility's forces under proper organization instal meters a great deal cheaper than the plumbers, and the installations are more uniform and systematic.

Meters, admittedly, will reduce the amount of water necessary to be furnished, and inasmuch as each gallon has a certain monetary value, a reduction in the number of these gallons will cause a reduction in the total cost of production.

With a meter schedule established so that the gross revenue will about equal the gross revenue from the flat rates, a few will have to pay a great deal more than they would under the flat rate, but the majority will not. In Miles City over 75 percent of the consumers are getting off cheaper under the meters than they were formerly under the flat schedule, altho the total gross revenue from the plant is substantially the same. The difference is paid by the 25 percent who were formerly getting more than they were paying for.

The saving to the utility is caused by the reduced cost for power, piping systems, conduits, filtering equipment, pumping units and general operating expense. I do not mean by this merely the reduced cost incident to the operation of the plant, but the cost of interest, depreciation and reserve, which would be required by the larger installation.

The question might then be asked, would it pay to instal meters in a plant already in operation and of ample capacity to supply present needs? I would again say, yes, i. e., provided the supply was pumped or treated, and generally speaking, in other cases also. It will be found with a pumped or treated supply that the reduced cost for power and chemicals will offset the extra cost for operating and maintaining the meters, and will also provide a reserve which will pay for the cost of the meters in from two to five years, provided the rates are such as to produce substantially the same gross revenue. If the supply is by gravity and ample, the meter system is still the only equitable and reasonable basis on which to render bills. Each consumer is then paying for his own supply in proportion to the amount used, while his neighbor is doing the same. Furthermore, where meters are installed, one does not find the lack of a satisfactory pressure, as is so often the case during the sprinkling hours with an unmetered system. This in itself should have some consideration, especially from the standpoint of fire protection.

Where the plant has reached or nearly reached its capacity, and enlargements are being considered, the most economical, and generally the most satisfactory solution of the problem will be found in the introduction of meters. Referring again to the plant at Miles City, at the time of installing meters we had about reached the capacity of our plant. To have provided a plant of ample capacity, with our prospective increase in population, and the rate of consumption at that time, would have required the expenditure of approximately $75,000. The cost for power (electricity) and chemicals at that time was approximately $7,000 per year. At the present time, on the same basis of consumption, the cost would be approximately $12,000 per year, but as a matter of fact is, with meters, only $6,000 per year. This is a saving of $6,000 per year, which, added to the $6,000 per year interest and depreciation on the $75,000 extension, shows an apparent saving of $12,000 per year. I say apparent for the reason that the meters installed cost $12,500, interest and depreciation on which amounts to $1,937.50 per year. Add to this the extra cost for maintenance and operation, $1,100 per year, gives a total of $3,037.50 to be deducted from the apparent saving, leaving a balance of $8,962.50 on the credit side of the ledger, a very good showing on an investment of $12,500.

Wood Stave Pipe Construction

Wound with Electrically Welded Continuous Wire

THE accompanying illustrations show the wood stave pipe wound with continuous electrically welded wire, under construction for the California Pine Box and Lumber Company, at Delleker, Cal. The compressed air was furnished by a portable gasoline engine and air compressor, and the electric current for welding was supplied by a small generator driven by the same gasoline engine.

Some most interesting problems were encountered in connection with this pipe laid on a compound curve thru a concrete wall. If sectional machine-banded pipe with collars and joints had been used on this particular part of the pipe line, no lengths longer than 4 inches could have been used on account of the curvature.

The photographs show the operation of the winding machine and the finished pipe ready for lowering into the trench. In addition to making the pipe continuous, this method does away entirely with the necessity of collars and joints, which must be used in sectional machine banded pipe.

Experience has very conclusively shown that the use of collars and joints is largely responsible for unfavorable leaks and for deterioration of the pipe at the joints. This new type of wood stave pipe has recently been developed in California and has been used in building two conduits of considerable length. Engineers are familiar with the continuous wood stave pipe in which the staves are secured by steel hoops secured by nuts and with the smaller sizes of wood pipe with the exterior of the pipe wrapped with a spiral wire winding, the pipe being made up in convenient lengths with the wire winding secured at the end. In laying pipe of this latter class, joints are required between the successive lengths of pipe.

ELECTRICALLY WELDED WIRE-WOUND WOOD-STAVE PIPE.

ABOVE: The machine for winding the wire about the pipe and the welding apparatus in operation.

BELOW: The completed pipe ready to lower into the trench.

The new type of pipe is a continuous stave pipe wrapped with a continuous helical winding of wire. The wire is wound on the pipe, as it is built over the trench, by a machine which winds the wire with a uniform tension and uniform pitch, both the tension and the pitch being adjustable according to the size of the pipe and the water pressure which it is to sustain. The machine is a simple and rugged affair, and has a gear wheel which encircles the pipe and is driven thru speed-reduction gearing by a small compressed-air motor. As this gear wheel is rotated around the pipe it is at the same time given a longitudinal motion along it. This rotating gear wheel carries rollers between which passes the wire to be wound on the pipe, and these rollers are adjustable to give the wire the desired tension. The wire is unwound from a reel that encircles the pipe head of the machine. When a new reel of wire has to be put on, the ends of the wires are welded together by a miniature electric welder furnished with the apparatus. After the electric welding, the joint is regalvanized. The necessity for the electric-welded joint arises from the fact that in order to pass thru the machine with even tension the wire must be of uniform diameter and flexibility, a result which could not be obtained with the telegraph lineman's splice.

As soon as the wire is wound on the pipe and before it is lowered into the trench, the entire pipe with the wire winding is given a heavy coating of asphalt. A sleeve slightly larger than the pipe has elastic and flexible ends made of fabric which fits snugly over the pipe. By means of a funnel on top, this sleeve may be filled with hot asphalt and it is then driven slowly along the pipe. By using galvanized wire and heavily coating the pipe with asphalt a long life for the pipe is assured.

The first pipe of this type was laid by the Standard Oil Co., of California, near Bakersfield, to furnish a water supply to a refinery. The pipe is 18 inches in diameter, about 2,400 feet in length and carries a maximum head of 60 feet. The California Pine Box and Lumber Company's line is 6,500 feet long and 10 inches in diameter and is under a maximum head of 200 feet. About 180,000 feet of No. 4 galvanized wire was used on this line, and 120 welds were made. The spacing of the wire was from 1 1/16 to 2 7/16 inches, according to the head of the pipe.

The line was laid thru very rough country and some curves as sharp as 30 degrees were made. The pipe was laid at the rate of about 450 feet per day. This pipe is low in cost, especially for pipe lines of small diameter.

The staves for the pipe can be shipped at much less cost than the made-up lengths of pipe. The pipe can be bent to sharp curves as it is built up, and a great deal of expense in carrying a pipe line thru rough country is saved by adapting the pipe line to the contour of the ground. The wire used is of 60,000-pound tensile strength and wire of various diameters is used, according to the size of the pipe and the pressure to be used in the pipe line.

THE QUINCY SHORE BOULEVARD

OF THE BOSTON METROPOLITAN PARK COMMISSION

The details of construction of this boulevard are told by the contractor in a brief recital of some of the difficulties met in what seemed to be a comparatively simple problem. The article will therefore be of interest particularly to contractors and to their engineers.

THE Quincy shore boulevard of the Boston Metropolitan Park Commission was built during 1915, actual work beginning about May 1.

The parkway constructed is 1.75 miles in length and the specifications up to the sub-grade called for the following quantities which were paid for at the prices given:

40,000 cubic yards earth grading, at 23 cents.
100,000 cubic yards filling, at 43 cents.
15,000 feet b. m. 2-inch spruce, at $50.
5,000 square yards rip-rap, at $2.15.

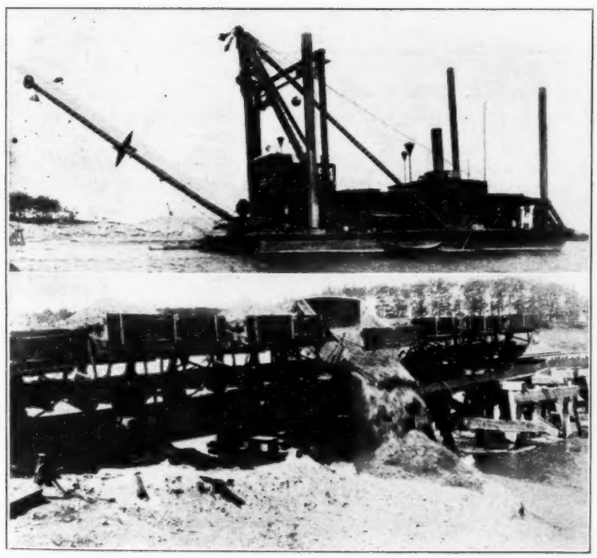
Most of the fill was in the two approaches to a proposed bridge and the amount of the filling was materially larger than that called for by the specifications, due to the fact that there was about 30 feet depth of mud on the bottom of the river into which the gravel used for filling must settle to reach a solid base.

The contractors first planned to bring up dredged material in scows and deposit it in place with a rehandler, but not having any contract providing suitable material for the purpose, a pile bridge was built, as shown in the lower of the first group of photographs, and cars were run out on either end and dumped over the side, as shown, until the grade was brought up level with the rails. The track was then thrown and dumping continued until the required width, about 60 feet, was obtained.

It was thought that material deposited in this way would work its way to hard bottom, so that pile foundations could be driven for the bridge abutments. The fills settled continually, going down 5 or 6 feet over night. The continued pushing of mud away from the approach fills forced the pile bridge up stream, so that it was necessary to rebuild the bridge. To save the cost of leaving material not paid for in the pile bridge approaches, they were kept as close to the permanent bridge as possible, another reason why the trestle was pushed out of line.

The river was very narrow at this point and it was necessarly to dredge about 6,000 cubic yards of the mud out of the center of the river, which was taken away in scows and dumped along the shore. Then the material for the approaches was dumped at both ends, as shown in the lower photograph of the first group, and picked up by the No. 4 dredge and placed on the approaches as they settled, as shown in the upper photograph. A smaller dredge was used on the up-stream side of the bridge to excavate and throw onto the bank material displaced by the approach fills. The bottom was disturbed so greatly that the whole channel was changed by the continual movement. About 30,000 cubic yards were placed in both shore ends of the approach fills. The pile bridge displaced by the movements of fills and bottom was rebuilt in the original position and four 20-inch I-beams, about 25 feet long, were placed in it to provide a place for taking out the smaller dredge when its work was finished.

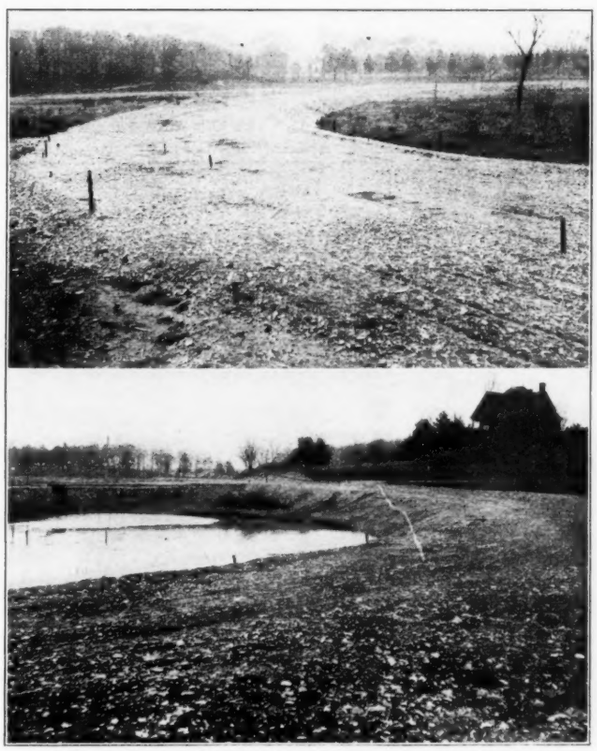
The borrow pits for the filling required were within 300 feet of the Quincy approach to the river, which was about the center of the work. At the close of last season's work all the grading had been completed and about 120,000 cubic yards of filling material had been put in place. The final touches on the fills and the slope-paving work have been completed this



PLACING MATERIAL IN FILL ACROSS TIDE FLATS.

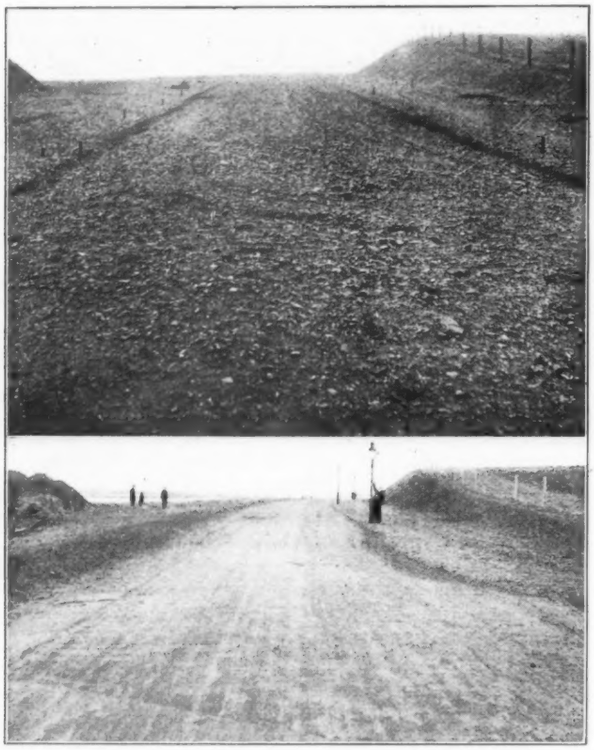
ABOVE: Dredge rehandling dumped material and placing it on the settling fill.

BELOW: Train of cars dumping first part of fill from trestle down its center.



QUINCY SHORE BOULEVARD. FILLS THRU LOW AREAS AND ALONG BANKS OF POND.

spring, the latter being the rip-rap of the bid prices above, and consisting of the paving of the slopes of the bridge approaches with large flat stones about 12 inches thick, with the joints filled with cement mortar. During the best months of last season the contractor operated day and night gangs which placed about 1,500 cubic yards a day, with a maximum of 2,000 cubic yards, very satisfactory progress in view of the depth of the fill.



QUINCY SHORE BOULEVARD, CUT AT SAILORS' HOME HILL.

ABOVE: Rough grade turned over to traffic.

BELOW: Finished grade with lawns graded and lamps installed, ready for boulevard surfacing by future contract.

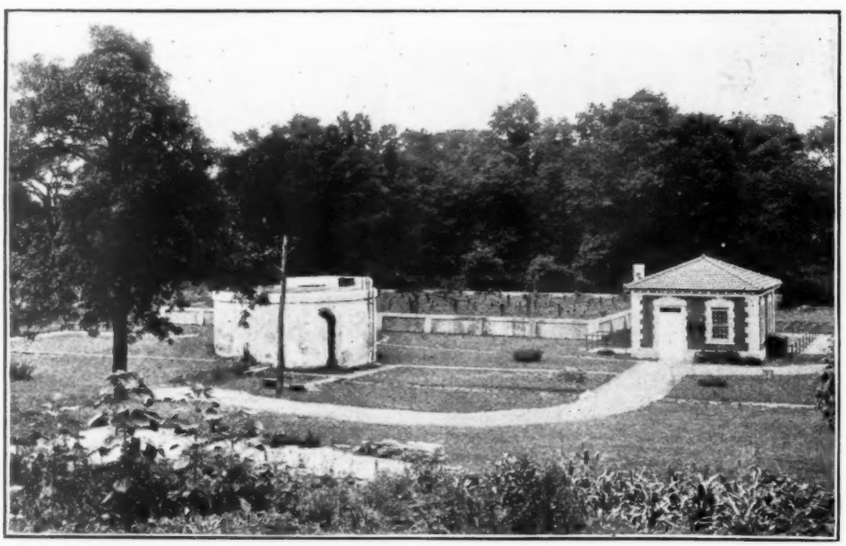
The second group of photographs shows two views along the river, called Black's creek, after completion to sub-grade.

The third group of photographs shows two views of the large cut made at the Sailors' Home hill, one when the grade had been completed and the other when it had been more thoroly smoothed up and lamps placed. About 30,000 cubic yards of material was taken out of this cut and placed on fills elsewhere on the work. The hill on the right shows the original surface of the ground. Traffic was let on this subgrade as soon as it was completed, the bottom being of good gravel, excellent to travel over. The only preparation for the travel was to rake off surplus stone and run a 2-horse roller over the roadway. The lower photograph shows the effect of traffic on the roadway.

The plant used on the road work consisted of a No. 20 Marion shovel, twelve 3-yard Kilbourne & Jacobs dump cars; eighteen 4-yard Western dump cars, a 20-ton Baldwin locomotive and an 18-ton American locomotive. After about a month at the beginning of the work, a Western Wheeled Scraper Co.'s spreader car was installed, relieving labor hire. A train of 18 cars was run out on the dump and the spare engine hooked onto the spreader car and graded the material to a level about 4 inches below the top of the rail. The spreader could be lowered or raised as desired. This made a great saving over the continual shoveling of the berms left by dumping the material from the dump cars.

The whole of the roadway will be covered with a permanent boulevard superstructure this season.

John Cashman & Sons Co. were the contractors on the work and it was under the direct supervision of C. J. Gilfillan. We are indebted to the courtesy of David J. White, manager of the company, for the data and illustrations of this article.



CIVIC BEAUTY IN A SEWAGE DISPOSAL PLANT. DESIGNED BY ALEXANDER POTTER, C. E.

RECENT DEVELOPMENTS IN BITUMINOUS PAVEMENTS

BOTH BITUMINOUS MACADAM AND BITUMINOUS CEMENT

By Arthur H. Blanchard, M. Am. Soc. C. E.,
Columbia University, New York City.

The author of this paper has been laboring diligently to reduce to some system the methods of construction and the nomenclature of bituminous pavements, of which there are many varieties aside from the asphalt pavement, which has been fully standardized. He outlined the difficulties and his methods of classification in an address before the Canadian Good Roads Congress so clearly that his plan is printed in the hope that it will hasten standardization in a field where practice is now very far from uniform.

BEFORE proceding with the discussion of the many improvements in the construction of bituminous macadam and bituminous concrete pavements which have been developed during the period from 1914 to 1916, it is advisable, in order to avoid misunderstandings, to quote the definitions of the two types of pavements as recommended by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

"Bituminous Macadam Pavement. One having a wearing course of macadam with the interstices filled by penetration methods with a bituminous binder."

"Bituminous Concrete Pavement. One composed of stone, gravel, sand, shell or slag, or combinations thereof, and bituminous materials incorporated together by mixing methods."

General.

Certain developments which are common to both classes of bituminous pavements will be discussed prior to considering improvements which specifically refer to each of the several types.

Foundations. There has been a general acknowledgement of the ultimate economy of constructing adequate foundations to support the amount and character of traffic which the several types of bituminous pavements are able to carry. In the case of bituminous macadam pavements, this development usually has been characterized by the construction of well compacted and, in many cases, thoroly filled broken stone foundations. In the case of bituminous concrete pavements, due to numerous failures which have occurred where this type of pavement has been built on old macadam or poorly constructed broken stone foundations, there has been a general tendency to advocate the use of cement-concrete foundations from four to six inches in thickness. It has generally been found that the cost of cement-concrete foundations does not exceed the cost of well compacted and filled broken stone foundations of equivalent strength. Furthermore the use of cement-concrete foundations renders repairs and renewals more satisfactory and much easier of accomplishment.

Non-Bituminous Highway Materials. There has been a general recognition since 1914 of the desirability of covering in specifications in more detail and with greater rigidity the physical properties of the aggregates to be employed and the sizes of the particles which compose such aggregates. For example, the 1914 Specifications of the American Society of Municipal Improvements covering bituminous macadam pavements state, with reference to the physical properties of the stone, that the rock employed must meet the following requirements:

"The broken stone shall be subjected to abrasion tests and toughness tests conducted by the Engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. The broken stone used for the construction of the first and second courses shall show a French coefficient of wear of not less than 7.0 and its toughness shall be not less than 6.0. The broken stone used for the construction of the third course and for the first and second applications of No. 1 broken stone shall show a French coefficient of wear of not less than 11.0 and its toughness shall not be less than 13.0."

The necessity for more carefully drawn specifications covering the sizes of the particles of which a given product of a stone crushing and screening plant is composed is illustrated by the following mechanical analysis of two products obtained from the same plant, both of which products passed over a section of a rotary screen having circular holes of 1¼ inches and thru a section of a rotary screen having circular holes 2¼ inches in diameter.

	Sample "A"	Sample "B"
Passing ⅛ inch screen	0.2%	0.1%
Passing ¼ inch screen	0.1	0.1
Passing ½ inch screen	0.4	1.1
Passing ¾ inch screen	2.2	12.6
Passing 1 inch screen	8.0	37.5
Passing 1¼ inch screen	29.1	40.9
Passing 1½ inch screen	27.1	7.7
Passing 2 inch screen	32.9	0.0
	100.0%	100.0%

It is hence obvious that for many forms of bituminous construction, in order to secure successful results, greater care must be used in the writing of specifications for products of broken stone. As an illustration of an improvement in specifications covering this detail, there is cited those adopted at the 1915 Convention of the American Society of Municipal Improvements covering broken stone to be used for the aggregate of one type of bituminous concrete pavement.

"Broken stone for the mineral aggregate of the wearing course shall consist of one product of a stone crushing and screening plant. It shall conform to the following mechanical analysis, using laboratory screens having circular openings: All of the broken stone shall pass a one and one-quarter (1¼) inch screen; not more than ten (10) percent nor less than one (1) percent shall be retained upon a one (1) inch screen; not more than ten (10) percent nor less than three (3) percent shall pass a one-quarter (¼) inch screen."

It is noted that in this form of specification an attempt is made to cover in the mechanical analysis only the limits of the smallest and largest particles. No attempt is made to secure

a carefully graded aggregate but simply a product suitable for the type of pavement in question and uniform in character. For example, the following mechanical analyses show three products used in the successful construction of three different bituminous concrete pavements of the type mentioned.

	Sample "A"	Sample "B"	Sample "C"
Passing ⅛ inch screen....	1.2%	2.7%	1.0%
Passing ¼ inch screen	4.2	5.6	2.5
Passing ½ inch screen....	34.7	45.0	30.8
Passing ¾ inch screen....	40.6	35.1	34.2
Passing 1 inch screen....	17.3	10.1	23.4
Passing 1¼ inch screen....	2.0	1.5	8.1
	100.0%	100.0%	100.0%

Bituminous Materials. There has recently been considerable discussion pertaining to the advisability of the adoption of so-called "alternate type" specifications in preference to the so-called "blanket" specifications for bituminous materials. By alternate type specifications is meant a series of specifications, each of which covers the physical and chemical properties of the most desirable grade of a given type of bituminous cement for the purposes for which it is to be used. On the other hand a blanket specification covers in one set of requirements, pertaining to physical and chemical properties, all the types of bituminous cement which are to be used in connection with the construction of a given kind of pavement. For example, in the case of specifications for asphalt cement for bituminous concrete pavements, it would be desirable under alternate type specifications to have not less than five sets of physical and chemical requirements, the limits for each requirement being as narrow as the several processes of manufacture would permit, while on the other hand a blanket specification would cover with a wider range of limits the same chemical and physical properties for the five types mentioned. As an illustration will be cited the limits in the cases of Specifications "A" to "E" inclusive under the alternate type specification method for specific gravity, and the penetration at 25 degrees C. (77 degrees F.).

	"A"	"B"	"C"	"D"	"E"
Sp. Gr.	0.97 - 1.00	1.00 - 1.03	1.03 - 1.04	1.025 - 1.05	1.04 - 1.06
Penet.	75 - 90	90 - 100	70 - 90	85 - 95	140 - 160

In the case of a blanket specification to cover the same grades of the several types, the limits for specific gravity would have to be 0.97 to 1.06 and the limits for penetration would be 70 to 160. The penetration test, for example, can only be of maximum value when applied to the grade of a specific type of bituminous cement which is most suitable for the type of pavement in question. In the case of the bituminous concrete pavement of the type mentioned, the proper penetration limits for a California asphalt lie between 70 and 90 while for a fluxed Bermudez asphalt to be used in exactly the same type of pavement and under the same conditions, the penetration limits should be between 140 and 160. It is evident that to attempt to cover the penetration limits for both materials in one specification is impracticable. In the first place such limits as 70 to 160 are so wide as to insure but little uniformity in different lots of the same material and in the second place an entirely unsuitable material of one class could be supplied under the maximum or minimum test limits of the other class.

The proper use of alternate type specifications allows the contractor to bid to supply so many tons of bitumen which will comply with any one of the sets of requirements. It will be noted, therefore, that the contractor is in exactly the same position as in the case when he bids to supply any asphalt cement which will comply with the requirements of a blanket specification.

Guarantees. There has been a general tendency to abandon the use of guarantees on bituminous pavements as it is believed that, with proper specifications and efficient supervision and inspection, guarantees are not necessary and that the requirement of a guarantee materially increases the prices bid on a given pavement. The subject of guarantees is too broad to discuss in this paper but it should be noted that under the title "The Economics of Guarantees of Pavements on State and Municipal Highways", it has been admirably treated by Mr. George C. Warren in a lecture in the Graduate Course in Highway Engineering at Columbia University, which lecture has been published under the auspices of the National Highways Association, Mr. Charles Henry Davis, President.

Bituminous Macadam Pavements.

In addition to the improvements noted above, the most notable recent development in the construction of bituminous macadam pavements has been in connection with the compaction of the road metal and the distribution of the bituminous materials.

As a result of the numerous failures of bituminous macadam pavements which have occurred due to the improper rolling of wearing courses of road metal prior to the application of bituminous material, there has been a general recognition of the necessity for more thoro compaction of the road metal. This principle has been recognized by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers in its 1915 Report, the conclusion referred to reading as follows:

"An important factor for successful results is the proper compaction by rolling of the road metal before the spreading of the bituminous material."

The above Committee emphasizes another improvement which is aimed at the use, in some cases, of an excess amount of bituminous cement in this type of pavement. This conclusion is as follows:

"Present indications are to the effect that the use of bituminous materials in quantities of more than 2½ gallons per square yard where the upper course of the macadam is to be 3 inches in thickness after compaction is inadvisable under the penetration method."

There has been a general recognition of the advisability of using properly designed distributers in connection with the application of bituminous materials in order to secure uniform distribution economically. Some specifications cover the requirements which a distributer must meet. For example, the 1914 Specifications of the American Society of Municipal Improvements contain the following paragraph pertaining to the pressure distributer.

"The pressure distributer employed shall be so designed and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gage so located as to be easily observed by the Engineer while walking beside the distributer. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributer shall be provided with wheels having tires each of which shall not be less than eighteen (18) inches in width, the allowed maximum pressure per square inch of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a two (2) foot diameter wheel, two hundred and fifty (250) pounds shall be the maximum pressure per

linear inch of width of tire per wheel, an additional pressure of twenty (20) pounds per inch being allowed for each additional three (3) inches in diameter."

This specification provides for a distributer by which it is practicable, under competent supervision, to secure uniform aplication of the bituminous material and allows the use of a pressure distributer without danger of rutting of the wearing course of broken stone by narrow tires carrying excessive weights.

Bituminous Concrete Pavements.

The improvements in the construction of bituminous concrete pavements to which attention should be called will be considered under the following classification of the three types into which bituminous concrete pavements generally may be divided. These types are designated as follows:

(A) A bituminous concrete pavement having a mineral aggregate composed of one product of a crushing and screening plant.

(B) A bituminous concrete pavement having a mineral aggregate composed of a certain number of parts by weight or volume of one product of a crushing and screening plant and a certain number of parts by weight or volume of fine mineral matter, such as sand or stone screenings.

(C) A bituminous concrete pavement having a predetermined mechanically graded aggregate of broken stone or gravel, either alone or combined with fine mineral matter, such as sand or broken stone screenings.

Patents. Unfortunately the present status of patent litigation has to be considered in connection with the discussion of the several types of bituminous concrete pavements. The majority of engineers and highway officials are interested in the types of bituminous concrete pavements which may be constructed without danger of litigation rather than in a prolonged discussion of the probabilities of successfully defending suits for infringement. There is ample evidence at hand that bituminous concrete pavements of type (A) may be constructed without danger of litigation proceedings, provided that the mineral aggregate is of the general character heretofore mentioned in this paper under the section "General. Non-Bituminous Highway Materials."

The history of litigation cases indicates that the construction of bituminous concrete pavements of type (B) on a large scale will in all probability lead to litigation. The same remarks apply to the construction of bituminous concrete pavements of type (C), except in the case of the so-called Topeka bituminous concrete pavement with an aggregate of the type specified either in the 1910 Topeka decree, or of the grading which was adopted at the 1915 convention of the American Society of Municipal Improvements.

Type (A). Minerals. Practice has demonstrated that broken stone, because of the satisfactory mechanical bond secured, makes the most suitable aggregate for this class of bituminous concrete, altho pavements constructed with gravel have proved satisfactory for light traffic where great care has been taken in the selection of the gravel and in the construction of the pavement. The development of the character of materials used in current practice has been covered in this paper under the title "General." Much more care has been taken in recent years with reference to the quantity of bituminous cement to be used in the mix. There has been a general recognition that the amount used depends upon the kind of road metal and the bituminous material, the character of the aggregate and the climatic conditions. For the product of broken stone heretofore mentioned, it has been found that bituminous concrete mixtures should contain between 5 and 8 percent by weight of bitumen.

Mixing. Many improvements are noted in the methods employed in the mixing of bituminous concretes. There has been a general evolution from hand mixing methods to the utilization of mechanical mixers especially designed for the manufacture of this type of bituminous concrete. The large contract for 35 miles of bituminous concrete pavement of this type around the Ashokan Reservoir, constructed under the direction of the Board of Water Supply of the city of New York, demonstrated the desirability of the manufacture of a plant especially designed for this class of work. The type finally evolved showed that it is practicable and economical to use a self-propelled plant, consisting of elevators, a rotary dryer, weighing devices and a mixer, having a capacity of from 800 to 1,000 square yards of 2-inch wearing course per day. Experience has demonstrated that, except on small contracts and for repair work, mixers which provide for the heating of broken stone by the use of a flame in the chamber should not be used on account of the danger of burning the broken stone or the bituminous concrete.

Laying. There has been considerable discussion pertaining to the proper type and weight of roller to be used for the compaction of the wearing course. Experience demonstrates that in order to secure an even surface and adequate compaction by thoro interlocking of the particles of broken stone, a tandem roller weighing between 10 and 12 tons should be used.

Seal Coat. Many methods have been developed for the application of the seal coat of bituminous material. It has been found that seal coats of from ½ to 1 gallon per square yard of bituminous cement are distributed most uniformly by the use of hand-drawn gravity distributers followed by a squeegee.

Seasonal Limitations. Experience in many localities has demonstrated that bituminous concrete of this type should not be mixed or laid when the air temperature in the shade is below 50 degrees F., as otherwise it is difficult, under average conditions, to secure an even and well-connected wearing course.

Type (B). Specifications for this type of pavement have, during recent years, generally stipulated that so many parts of broken stone and so many parts of sand or other fine material are to be mixed with a certain amount of bituminous cement. By the use of this specification, unless employed under unusual supervision, it has been found to be impracticable to secure a well-graded aggregate. In many cases the mixture has contained an excess of broken stone with insufficient fine material to fill the voids therein, while in other cases it has contained an excess of sand in which the broken stone exists as isolated particles. It is the conclusion of many engineers, because of the conditions described, that when bituminous concrete pavements are to be employed either type (A) or type (C) should be selected.

Type (C). During recent years, the bituminous concrete pavements of this type which have been most extensively employed are known as bitulithic, Warrenite and Topeka.

Bitulithic and Warrenite. Differentiation. The general use of bitulithic and Warrenite bituminous concrete pavements thruout America has brought up for discussion the matter of the fundamental differences between these two types of patented pavements. It is believed that it will be of interest and value to the engineering profession to submit the following statement, prepared by Mr. George C. Warren, president, the Warren Brothers Company, for the information of the engineers enrolled in the Graduate Course in Highway Engineering at Columbia University:

"Bitulithic and Warrenite mixtures are both made under the provisions of the Warren patents, which the courts have held 'cover the product no matter how produced.' Bitulithic is designed to meet the conditions generally prevailing on city streets, and Warrenite is to meet such conditions as may arise on country roads so as to meet the physical and economic conditions and public demands as to cost.

"Generally speaking, bitulithic is mixed by a plant which is too cumbersome to meet country road conditions, which pro-

vides for combining the materials proportioned by separation of sizes of the aggregate, after heating, and then recombining by weight.

"Warrenite is, generally speaking, mixed by a plant so portable that it may be set up either alongside the railroad, along the side of the road being constructed, or in the quarry or gravel bank from which the bulk of the aggregate is being procured, as may be most economical in any particular case. This plant is constructed on the principle of proportioning the several separated sizes by careful measurement by bulk before heating and retaining the batch so measured as a separate entity thru the process of heating and delivery into the mixer in which the bituminous cement is added.

"Generally speaking, crushed stone predominates in the fine aggregate of bitulithic, while sand predominates in the fine aggregate of Warrenite; also, fine crushed stone and sand respectively are correspondingly used for the seal coat aggregate.

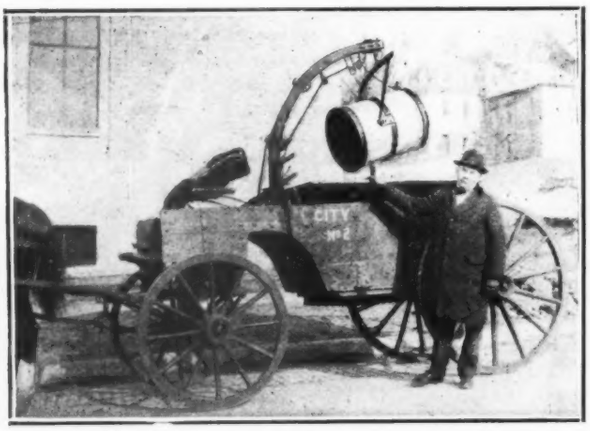
"In the selection of quality of material (whether gravel or crushed stone) for the coarse aggregate a greater latitude is permitted in the case of Warrenite to practically meet the conditions of less opportunity for selections which are liable to prevail in localities considerable distance from railroad centers. This latitude is allowed, because, while the traffic conditions on country road thorofares are in point of weight and concentration of traffic rapidly becoming fully as severe as on most city streets, there is the important difference that on country roads generally the traffic is more exclusively of the motor vehicle rubber tire type and consequently less exaction in physical properties of the quality of the stone forming the basis of the aggregate is necessary. Also, unfortunately, many city streets are abused by constant excessive sprinkling or daily scoured by pressure flushing machines, a practice which is more or less injurious to any road surface, while country roads are seldom, if ever, wet except by rainfall; therefore, in cases where the very best quality of stone is unavailable, it would be safe to use stone of slightly lower quality in Warrenite on a country road, altho the same quality stone might not be safe for use in bitulithic on a city street."

Topeka. In many specifications the mineral aggregate for the Topeka pavement specified has been that contained in the decree of 1910, namely:

"Bitumen, from 7 percent to 11 per cent.
Mineral aggregate, passing 200-mesh screen, 5 to 11 percent.
Mineral aggregate, passing 40-mesh screen, 18 to 30 percent.
Mineral aggregate, passing 10-mesh screen, 25 to 55 percent.
Mineral aggregate, passing 4-mesh screen, 8 to 22 percent.
Mineral aggregate, passing 2-mesh screen, less than 10 percent."

Many unsatisfactory pavements have resulted by the unintelligent use of this grading. It has been found necessary, in order to secure successful results, to specifically define the character of the sand or other fine material which shall be employed in order to secure a satisfactory grading. Many specifications now cover the sand grading with almost the same care as in the case of sand grading requirements for sheet asphalt pavements. In order to encourage the use of a more satisfactory grading for this type of pavement, the American Society of Municipal Improvements in 1915 recommended the adoption of the following grading:

Passing	200-mesh screen,	7 to 10 percent.
Passing	80-mesh screen, but retained on 200,	10 to 20 percent.
Passing	40-mesh screen, but retained on 80,	10 to 25 percent.
Passing	20-mesh screen, but retained on 40,	10 to 25 percent.
Passing	8-mesh screen, but retained on 20,	10 to 20 percent.
Passing	4-mesh screen, but retained on 8,	15 to 20 percent.
Passing	2-mesh screen, but retained on 4,	5 to 10 percent.



Street Cleaning Apparatus in Grand Rapids

The system used by William M. Walsh, highway commissioner, in cleaning the streets of Grand Rapids, Mich., is one of his own invention and is said by authorities to be one of the most efficient in operation.

Several features combine to make up the system, principal among them being the collection wagon. It is an ordinary base-dumping vehicle, equipped with Walsh's patent crane. Over steel pulleys a wire cable runs from a crank at the side of the wagon. The crane is swung from side to side by a lever and the arms of the yoke are hooked over the filled garbage cans, special iron hubs receiving the hooks. Turning the crank, the can is raised to a position above the wagon, where a ratchet on the crank holds it stationary. By shifting gears, the can is then dumped, when the crank tightens a second cable terminating in a steel catch, which hooks to the bottom rim of the can. Each can holds 400 pounds and is raised and emptied with ease.

Walsh has numerous collection stations, where the gangs of white wings leave the filled cans and procure empty ones. Two-wheeled carts, also designed by Walsh, are equipped with steel hooks terminating a semi-circular steel arm. The hooks fit over the iron nubs on the cans and the operator places them in position by manipulating the arm, which is held stationary by a hook fastened to the push handle.

Gangs of white wings collect the refuse in the streets with brooms and steel pans and when a can is filled it is taken to a collection station. There it is covered with a galvanized iron cover and held until a collection wagon appears. One wagon easily handles the cans deposited at a station and empties the refuse on the city dumps, where it is used to fill in low places.

QUESTION DEPARTMENT

Non-Partisan Management of Municipal Water Works

This city has just installed a gravity water works system at the expense of $400,000 and we are now concerned about divorcing the management of it from politics by the establishment of a board of a non-partisan character who will manage the works.

I would like to get information as to what other cities of this size (population 5,500) have done along this line and you can also probably cite me to some articles in your magazine which discuss such matters.

B., City Attorney.

In the city of Erie, Pa., the board of water commissioners is composed of three members with terms of three years, one being appointed each year by the Court of Common Pleas of the county, the intention being that the appointments be as far from politics as possible. This seems to be the result, and when a good man is secured he is continued for several terms. Almost every commissioner, since the beginning of the system in 1867, has served at least two terms and most of them from three to five terms. The tenure of office of the executive officers is consequently secure and appointments to the office of secretary and treasurer have been life appointments of men who have demonstrated their ability under their predecessors. The present incumbent has been in office fifteen years, following eighteen years as assistant secretary. While changes in superintendent and in engineer have been more frequent, they have been mainly because the incumbents moved on to other situations preferred by them.

Other cities have similar systems, the appointing power being selected according to local conditions and laws.

Permanency of tenure of office by the executive employes is the principal essential to secure good men and keep them and this is only secured by making the appointments for competency only and removals for political reasons impossible.

Another essential is to keep the control of the funds necessary for operating and maintenance purposes, in fact all funds, except, possibly, the authority to issue bonds, in the hands of the commission, otherwise councilmen may demand favors as the price of votes for the necessary appropriations.

Producers of Tar

We are desirous of getting some data in regard to the tar and tar producing companies who produce tar for the markets of the United States.

Would it be asking too much of you to give us the names of several of the larger companies? Also, let us know what companies produce tar for special purposes, and what they are especially used for.

J., Cincinnati, O.

All the plants producing coal gas for illumination are producers of tar, also the plants using retorts of various sorts for producing coke. Water-gas plants produce water-gas tar, which is of somewhat different constitution, and the combined coal and water-gas plants produce tar which may be a mixture of the two. A list of the gas companies in the country will be found in Brown's "Directory of American Gas Companies" ($5). It also gives the names of the companies owning more than one plant, some of which are thus large producers.

Tar is really put on the market by companies which take the tar from the various plants, refine it and put it into shape for practical use. Among the principal companies in this business are the Barrett Manufacturing Company, 17 Battery Place, New York, who produce tar for any purposes desired; Warren Brothers Company, Boston, Mass., who prepare tar largely for paving purposes, but also for other uses; Warren Chemical and Manufacturing Co., 17 Battery Place, New York; United Gas and Improvement Co., Philadelphia, Pa.; Bayway Chemical Co., Elizabeth, N. J.; Samuel Cabot, 141 Milk street, Boston, Mass.; Coal Tar Products Co., 570 Smith street, Brooklyn, N. Y.; Semet-Solvay Co., Syracuse, N. Y.; United Roofing & Mfg. Co., Morris Bldg., Philadelphia, Pa.; H. F. Watson Co., crude and refined tar, Erie, Pa.; Philip Carey Mfg. Co., Lockland, O.; Chatfield Mfg. Co., 74th and Lebanon, Carthage, Cincinnati, O.; General Roofing Mfg. Co., 17th and Southern Railway, East St. Louis, Ill.; F. J. Lewis Mfg. Co., 2513 South Robey street, Chicago, Ill. There are also some manufacturers of pine tar.

Trucks for Road Construction

I have about 18 miles of tarvia macadam and plain macadam roads to build in the next four years. At present teams are very scarce. Do you think it advisable to purchase trucks for my stone hauling? If so, what size and kind of trucks would you advise purchasing?

B., Contractor,———, Ind.

This should be the place for the economical use of motor trucks for hauling the stone and other materials. In order to choose the size and kind of truck intelligently there should be full information about the loading place for the stone, the nature of the roads over which the stone is to be hauled, as to surface and maximum grades and extent of bad stretches in them. A truck can then be chosen to suit these conditions exactly, and it would suit any similar conditions. Trucks of 3½ to 5 tons capacity seem to be most popular for such work as this but 7-ton trucks are used also, the condition of roads as stated above, governing the size very largely.

One important factor in the economy of the use of trucks is the kind of facilities for loading the trucks. They should be loaded quickly so as to lose as little time from the road as possible. Car unloaders or bins which can be filled between trips and emptied quickly into the trucks are quite necessary. The methods of dumping the stone on the road and of spreading it in the process of dumping are also of importance and will give points to consider in choosing the kind of trucks.

Many reports of the results of the use of trucks are given in MUNICIPAL ENGINEERING in the Motor Truck Section (colored insert) especially in the numbers for January, February and March, showing loads carried, speed of operation, cost of operation, and in some cases comparisons with cost of horse traction.

FIRE DEPARTMENT

Motor Fire Apparatus Costs

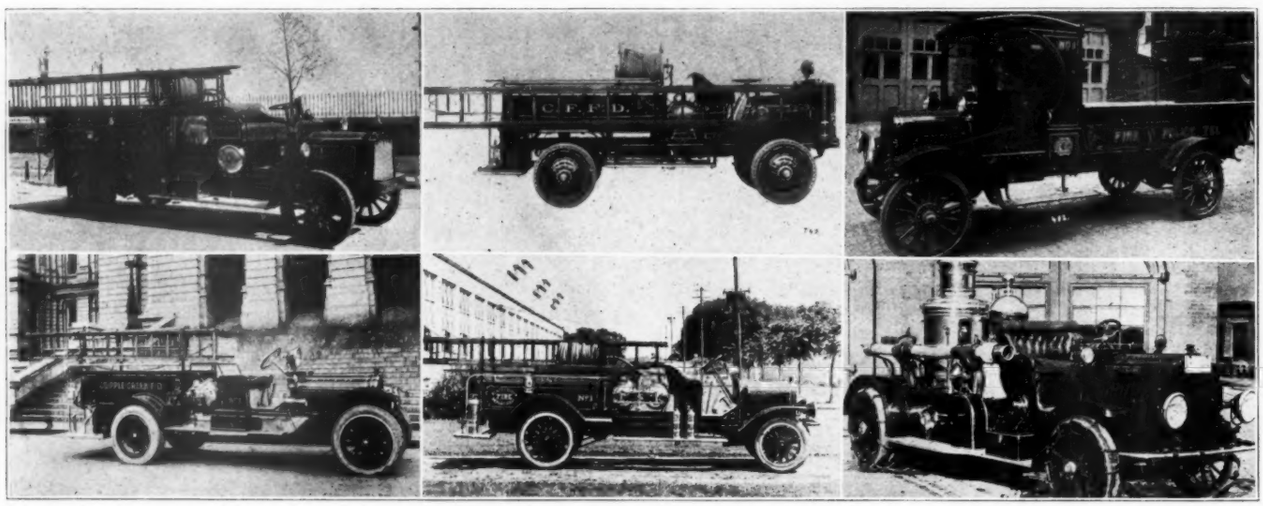
One of the most recent noteworthy fire apparatus installations, both as to chassis and paraphernalia, is found in the 6-cyl. 60-h.p. White combination installed by the city of Dover, N. J. The tank pressure is created, not by chemical action, but by an auxilliary air pressure system, consisting of a steel tank of compressed air on the left running board with a regulating valve and gage in the line between the air tank and the chemical tank. This system permits the increase of air pressure in the chemical tank in accordance with the distance the stream is to be thrown, and the air pressure also may be increased as the chemical is used. The stream, therefore, can be as powerful at the end as it was in the beginning, and it is unnecessary to refill the chemical tank when only a portion of the contents has been used.

For this class of apparatus, where seconds count in getting under way, the electrical starting system is particularly valuable. It has the usual advantage of preventing the motor from stalling at all times and without any attention on the part of the driver. Both the functions of starting and lighting are performed by one mechanism, the motor generator, which is mounted at the forward left side of the engine and driven by silent chain.

Engine Both Generator and Motor.

The entire control is centered in a single knife-blade switch located on the dash. When this switch is closed, the electric system assumes its duties and performs every function without any further attention and without the assistance of any automatic regulating devices. Both the control of the generator capacity and the change of its functions from that of a generator to a motor are accomplished entirely by the design of the unit itself. Closing the switch connects the 9-cell battery and puts the motor in operation, thus starting the engine. As soon as the latter is turning over at a speed in excess of a few hundred revolutions per minute, the generator being a slow type, the voltage of the motor generator exceeds that of the battery, and the battery is charged at all speeds above this point, at a definite governed rate. The 18-volt storage battery is "floated" on the line in such manner that the motor changes to a generator and back again to a motor, according as the electrical pressure rises or falls above or below that of the battery.

At engine speeds above a certain definite point it is a generator and below that point it becomes a motor, so that should the engine stall in traffic the electric motor will automatically pick it up and restart it without any attention on the part of the driver. It will be apparent that this should constitute



NOTEWORTHY INSTALLATIONS OF MOTOR FIRE APPARATUS.

PACKARD 2-TON CHAINLESS COMBINATION, RIVER FOREST, ILL.

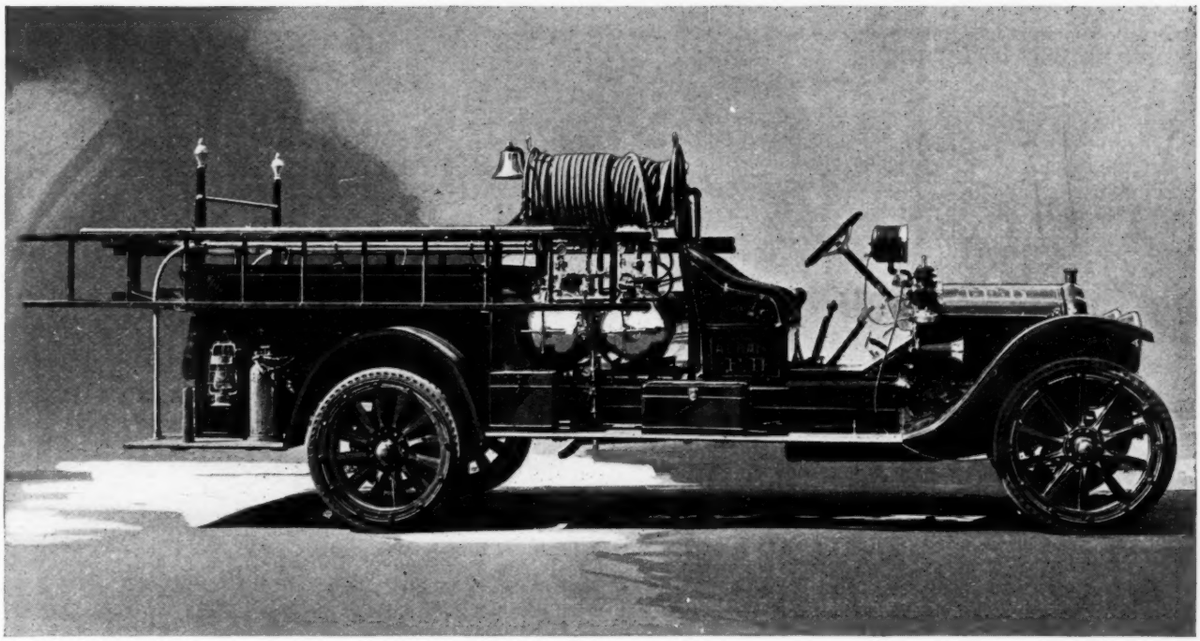
WHITE COMBINATION CHEMICAL HOSE AND LADDER TRUCK, CRIPPLE CREEK, COLO.

JEFFERY "QUAD" COMBINATION CHEMICAL HOSE AND LADDER TRUCK, CHIPPEWA FALLS, WIS.

DART COMBINATION CHEMICAL, HOSE AND LADDER TRUCK, STATE CENTER, IOWA.

SERVICE EMERGENCY FIRE TRUCK, COLUMBUS, OHIO.

ALTOONA, PA., STEAMER MOUNTED ON WHITE CHASSIS.



WHITE COMBINATION CHEMICAL AND HOSE, ALBANY, ORE.

a very valuable feature of the motive power of any piece of fire apparatus where the delay incident to having to restart the motor by hand-cranking might be serious.

Big Saving at Pontiac, Mich.

Chief J. B. Austin, Fire Dept., city of Pontiac, Mich., submits the following costs covering operation of three autos as compared with six horses:

Up-keep 6 horses (period of 12 mos.)	$941.76
Up-keep 3 autos (period of 12 mos.)	282.42
Saving in favor of autos	659.42

Following appears up-keep, or running expense, of the motor apparatus from Nov. 1, 1914, to Oct. 31, 1915:

Chief's Car:—
Ford Roadster 25-gal. chemical tank and 150 ft. hose,

Gasoline 274 gal.	$28.13
Motor oil, 19 gal.	4.35
Repairs to axle	47.90
Tire	56.69
Pres-o-Lite tank	5.25
Spark plugs	3.00
Tire chains	5.00
Traveled 1895 miles	$150.32

Answered 121 alarms.

American La France Auto Truck No. 1:—

Gasoline 152 gal.	$15.99
Motor oil 7 gal.	2.18
Repairs	1.76
Prest-o-Lite	3.00
New lighting system	13.13
Tire	66.20
Traveled 141 2-10 miles	$102.26

Answered 96 alarms.

Seagrave Auto Truck No. 2:—

Gasoline 139½ gal.	$14.88
Motor oil 10½ gal.	3.24
Repairs	4.22
Tire chains	7.50
Traveled 134 2-10 miles	$29.84

Answered 50 alarms.

Cost of Four Units Lumped.

The following costs, submitted by Chief Hugh Montgomery, Fire Dept., Houston Heights, Tex., cover the up-keep on one Federal service truck; one Ford chief's car; one Pierce-Arrow hose wagon; one Robinson hose wagon, for a period of one year. In other words the entire cost of maintaining these four pieces for a period of one year is as follows:

Cost of repairs, including labor and material	$140.00
Cost of gasoline	80.15
Cost of oil	4.50
Cost of grease	2.20
Miscellaneous expense	105.00
Total cost	$431.85

Distance traveled, 302 miles each.
Number of alarms answered 144.

Big Snows and Heavy Grades.

Chief Charles H. Gunn, Fire Dept., Cripple Creek, Colo., writes us as follows:—

"Some of our hills have 25 per cent. grades but our White Combination makes the Third street hill (20 to 25 per cent. grade) in deep snow. To negotiate the hill at high speed in good weather when the road is in fair shape is a task which would be highly creditable to motor apparatus, but on one occasion there was 18 inches of snow and the truck was forced to break its own road. Considering also that the average elevation is about 9,000 feet and that many of the runs of the fire department are hilly, the work of our truck firmly convinced the municipal authorities that the motor combination truck was far superior to the horse unit. The 60-h. p. White engine gives ample power for the steepest grades in Cripple Creek and is capable of propelling the truck faster than it is practical to drive it on most of the streets. The principal equipment consists of a large chemical tank and two portable tanks, extension and scaling ladders, hose, nozzles, and the customary paraphernalia of axes, lanterns, hooks, crowbars, etc.

Chief William Wessel, Fire Dept., Imperial City, Cal., submits the following record covering the up-keep on a Federal combination chemical and hose wagon, for a period of one year:—

Cost of repairs, including labor and material	(None)
Cost of gasoline	$30.00
Cost of oil	4.00
Cost of grease	15.00
Miscellaneous expense	(None)
Total cost	$49.00

Distance traveled, 500 miles.
Number of alarms answered, 26.

Low Cost for Four Years.

Chief J. S. Hynes, Fire Dept., Grand Junction, Colo., submits the following combined costs of one Seagrave and one Thomas Combination for period from June 1, 1911, to March 1, 1916:—

Cost of repairs, including labor and material	$130.00
Cost of gasoline	142.50
Cost of oil	18.75
Cost of grease	5.00
Miscellaneous expense	50.00
Total cost	$346.25

Distance traveled, 357 miles. Cost per mile.....$1.00
Number of alarms answered, 242.

"One hose wagon, with team," states Chief Hynes, "costs us annually more than the combined up-keep on two motor pieces for a period of four years and eight months."

Horse Cost $15.00 *Per Month.*

"Motor fire apparatus," states Chief Daniels, Fire Dept., Columbus, O., "costs about one-fourth as much to maintain as horse-drawn apparatus. Horses eat every day the whole year round, while the motors consume only a few gallons of gasoline when in service and none at all while waiting for calls in the houses. It costs $15 a month to keep a horse; with 130 of them in the department, this used to run into a big sum."

The motorization of the department at Columbus, O., began three years ago, when three of the outlying houses were furnished with motor trucks, and 13 of the 17 engine houses of the city are now motorized. The new trucks are costing the city from $4,000 to $10,000 each, and about $100,000 worth of such equipment is now in use. The old steamers are being retained, and will be pulled to fires as trailers on the hose trucks. Later, it is expected, the city will purchase motor pumps. While the new apparatus can make a speed of 40 or 50 miles an hour, it is not necessary, says Chief Daniels, to go faster than 20 or 25 miles an hour.

"Motor vs. Horse" in Des Moines.

Chief Will Bennett, Fire Dept., Des Moines, Ia., submits the following comparative costs covering up-keep on combination chemical and hose units, same make, one motor and one horse-drawn for same period, 1915:—

Motor apparatus:

Cost of repairs, including labor and material	$100.00
Cost of gasoline	30.00
Cost of oil	8.00
Cost of grease	1.00
Miscellaneous expense	11.00
	$150.00

Distance traveled, 332 miles. Cost per mile.....$0.45
Number alarms answered, 79.

Horse-drawn apparatus:

Cost of repairs, including labor and material	$ 25.00
Cost of feed	187.00
Cost of shoes	36.00
Harness repairs	2.00
	$250.00

Distance traveled, 59 miles. Cost per mile.....$4.22
Number of alarms answered, 69.

Monolithic Brick Pavement in Pennsylvania Terminal

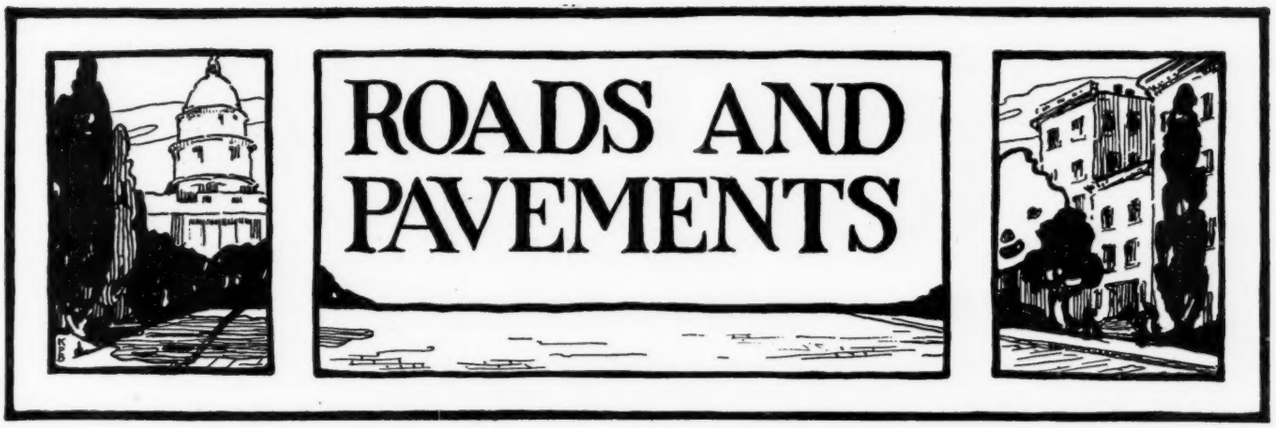
We are showing two views of monolithic brick pavement construction as laid in and about the Pennsylvania railroad terminal in New York City.

This pavement has been down for a period of five years, is laid on a sand-cement mortar bed and is separated from the sheet asphalt paving of Seventh avenue by a steel protection plate.

In spite of the heavy traffic entering and leaving the station, there has been no breaking down of the brick pavement at its intersection with the sheet asphalt. Even at the points where the traffic is most heavily concentrated, at the entrances between the columns, the bricks have only worn to a smooth surface. No cracks of any sort have developed with the exception of one across the front of the north entrance to the station, which was caused by a settlement due to the excavation of the street for the Seventh avenue subway.

Shortage of Paper

The shortage of paper is so pressing that the U. S. Department of Commerce has issued a bulletin for posting, asking everyone to save waste paper and rags until the usual sources of paper-making materials are again available.



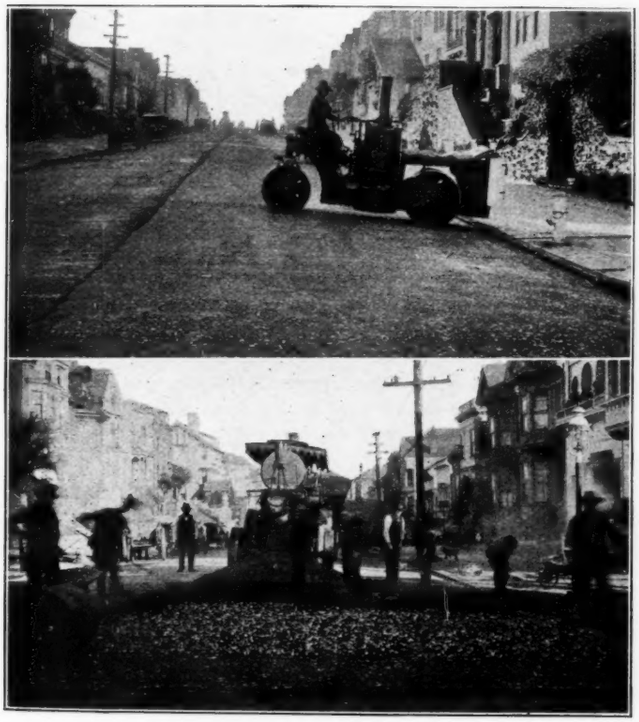
Reducing Slippery Pavements in San Francisco

By D. J. McCoy, Superintendent of Street Repair Department

The following relates to improvements in street or road pavements and the objects of the invention are to provide a street or road pavement which will prevent skidding, and also to provide an improved process of making the same.

In the accompanying photograph is a perspective view of a street in the process of construction according to my invention.

The preferred process of making my improved street or road pavement is to spread evenly, upon a suitable level foundation, to a depth of not less than one and not more than two inches, hot asphaltum, in pulverulent or granular form, heated by any suitable heating means. The foundation is also to be heated, if it is old asphaltic pavement. I next distribute evenly, thru the layer of asphaltum thus spread over the foundation, clean sharp rock broken to a size of not more than two inches and not less than one-quarter of an inch, preferably not less than one-half of an inch, and heated to a temperature not less than the temperature of the asphaltum. I then roll the asphaltum and rock together with a heavy roller, the result of which is to force the rock down into the asphaltum until the upper surfaces of the pieces of broken rock are level with the rolled layer of asphaltum. The larger pieces will be pressed down so that their lower points or surfaces may be driven into the foundation beneath.



TOP VIEW SHOWS A FINISHED SURFACE; HLF OF STREET RESURFACED WITH ASPHALT AND ROCK.

BOTTOM VIEW SHOWS METHOD OF RENDERING ASPHALT WEARING SURFACE "NON-SKID" BY HEATING STREET WITH A LUTZ SURFACE HEATER. ROCK IS ROLLED WHILE SURFACE IS STILL HOT.

No Round Surfaces.

The result is a pavement consisting principally of asphaltum and having interspread therein pieces of rock varying sizes and presenting no round or water-worn surfaces. I have found that gravel is unsuitable for such a pavement on account of the round water-worn surfaces of the gravel not offering sufficient resistance to skidding. The rough surfaces of the broken rock on the other hand offer great resistance to skidding and this is also increased by the fact that there are slight crevices between the rock and the surrounding asphalt, into which the rubber tires can enter and hold the wheel against the skidding.

The heating of the broken rock to a temperature as high as that of the asphaltum is an important feature. But for this step of the process, the asphaltum immediately surrounding the pieces of broken rock would be chilled and become hard and could not be made, by the operating and rolling, to bind around the pieces of broken rock, as effectively as with my improved process.

I have found that a pavement of this construction is very effective in preventing skidding, while at the same time the surface is free from projections sufficiently high to create any impediment to rapid traveling.

An important advantage of my invention is its comparative cheapness, as the rock and asphaltum do not, as with pavements now ordinarily laid down, have to be mixed together in the factory before being brought out to the place where they are to be used.

Resurfacing of Asphalt.

The method of smoothing up a wavy asphalt pavement was introduced into San Francisco during the month of January, 1913. The first Lutz machine was leased by the city on January 17th, 1913. On April 24th a second Lutz machine was received and on September 11th two others. Three of the machines have been working almost continuously since the above date. Although, owing to various reasons, a small percentage of the area covered has not been up to standard, the greater percentage has been entirely satisfactory, particularly the work done during the past fiscal year.

A total of 171 blocks of asphalt pavement has been resurfaced, which in square feet amounts to 2,669,371. The cost

of the work including overhead, repairs, royalty, etc., has amounted to 4.8 cents per square foot.

The leased price of each machine is $1,800.00 with the understanding that a minimum of 90,000 square feet per year must be performed. This amounts to $500.00 in royalty.

The average force required to operate one machine is one foreman, two engineers, fourteen laborers.

The operation of two machines working together requires one foreman, three engineers, eighteen laborers.

The average day's work for the entire year for the three machines has been 10,300 square feet.

Each machine carries a hood with a heating surface of 60 square feet. The heat from an oil flame is transmitted to the hood by means of a baffle wall and is evenly distributed. The hood is dropped to the surface and the pavement given a slow heat. This softens the asphalt so that the surface can be made uniformly rough by means of hoes especially cut for that that purpose. A thin layer of new asphalt wearing surface is then spread and raked over the heated surface and a 5-ton steam roller sent on to it immediately. By this method the bond between the old and new surface is perfect, numerous tests failing to show where the two surfaces come together.

Expansion Joints for Brick Pavements

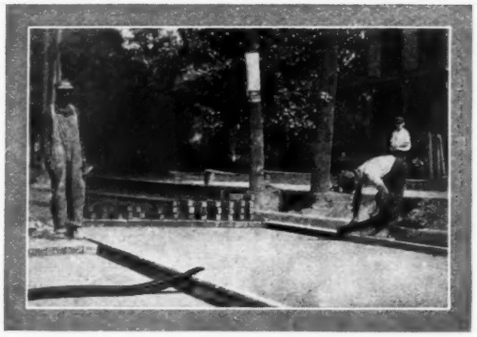
By H. C. Innes, Consulting Engineer, Cincinnati, O.

Small important details omitted in paving practice, have frequently caused damage to or deterioration of excellent materials and usually such omission or neglect is responsible for many of the criticisms pointed toward a material which does not show on the surface the best appearance. Each of the several steps taken in the construction of a brick wearing surface, and the various products or materials forming the finished pavement are essential, and must have the best of attention afforded to secure the good results desired.

The material occupying the smallest space in a brick street is the expansion joint. In cost, it is likewise the cheapest material in place, and for this reason can be looked upon as the most insignificant part of the roadway, yet this expansion joint area performs a most important function in the success of that pavement.

Progressive steps in the construction of a brick pavement, both as to material and method, as compared with the earlier practice, have done much toward perfecting this class of wearing surfaces for our city streets and country roadways; the dampened and hand-rolled sand cushion versus the merely luted cushion; the carefully mixed and placed strong grout filler for full depth versus the sand or soft filler, and lastly the prepared, preformed expansion joint for full depth and width versus the poured, unknown depth and irregular width of the joint.

The preformed joint, ready to place in position along the curb or gutter, insures a convenience to the contractor, a factor of safety in several ways for the engineer, and provides



the correct width with the full depth so essential for a hard surface pavement which is acted upon by heat, cold and moisture.

Its entrance as a material for paving work has seemingly perfected and improved the general method of construction; some of the advantages gained being a regular full width and depth of joint, the avoidance of any hard foreign material entering the joint space, which would tend to destroy the object of an expansion joint. The fact that it is placed in position ahead of the laying of the brick shortens the time for the completion and final acceptance of the contract by the officals. It avoids going back pulling strips, resetting the strips, cleaning out the joint space, heating and pouring hot bituminous material, etc., as compared with the former practice of pouring. No small plant equipment is needed or capital invested for the outfit. Being in unit form, should occasion arise during maintenance of the surface, the old joint can be removed and replaced with new sections.

Practical experience has demonstrated that the size of expansion joints for best results is obtained by placing along each curb a one-half inch joint for street widths less than 20 feet, three-fourths inch each side for streets 20 to 30 feet wide and one inch for widths of roadways greater than 30 feet, all for full depth of the brick.

The preformed type of expansion joints and the above sizes have the endorsement and approval of those most interested in the success of brick paving, namely, the National Paving Brick Manufacturers Association, as mentioned in the new specifications.

Roller Heater Melts Snow to Permit Finishing Asphalt Macadam

The heater shown in the accompanying photographs was used last December by Jno. A. McGarry & Co., of Chicago, to finish up 5,400 square yards out of a total of 63,000 square yards of asphalt penetration work in Glencoe, Ills.

The two-inch stone wearing surface was already spread ready for pouring when it was covered by four inches of snow. The main part of the snow was moved by hand at a

a total cost of	$17.00
Rent of Barber heater four days at $20.00	80.00
Engineer at $6.50 (including car fare) four days	26.00
Helper at $3.50, four days	14.00
Pocahontas coal, one-half ton a day, four days, at $6.25, delivered	12.50
Total	$149.50

This amounts to nearly 3 cents per square yard.

This type of heater was made from an 8-ton roller, the special flue being mounted on it to carry the flue gases over the top and down to the 5 ft. by 7 ft. hood.

The heater melted the snow and warmed the road surface with a hot blast at high temperature and made possible the sat-

(1) SHOWS THE ROAD WITH THE HEAVY SNOW SHOVELED OFF BY HAND AND THE TRACK OF THE HEATER WHERE IT HAS DONE ITS WORK ON HALF THE STREET.

(2) THIS SHOWS THE HEATER WORKING AHEAD OF THE ASPHALT POURING GANG. GANG WORKING AT HALF SPEED, 1,500 YARDS A DAY, AS AGAINST 3,000 IN WARMER WEATHER.

(3) NEAR VIEW OF HEATER, SHOWING DRAFT PIPE AND HOOD. THE CHAINS ARE USED FOR LIFTING THE HOOD OFF THE GROUND WHEN MOVING.

(4) THIS VIEW SHOWS THE HEATER COING OVER THE BAD PLACES, SWEATING UP THE ASPHALT FOR PATCHING.

isfactory completion of the asphalt work at a comparatively low cost.

The two inches of crushed stone for the wearing surface was already in place on the concrete base when the snow came. It was decided to make an effort to remove the snow, heat the stone and finish the pouring before winter set in. For this purpose gasoline, hand-propelled road heaters were thought of, but proved to be too costly and slow for this particular work. However the contractor set a crew to work which removed the heavy part of the snow with brooms and shovels at a cost of $17.00.

Then a Barber heater, with a patching hood, was hired at $20.00 a day. The engineer received $6.50 and his helper $3.50 a day, including car fare. Pocahonatas coal at $6.25 per ton, delivered, was used and about half a ton a day was necessary for this work. The heater consisted of an 8-ton tandem roller, rigged up with a special flue leading from the boiler over the top and down to a 5 by 7 ft. hood which could be lowered till flush with the pavement. The flue gases were blown thru by a forced draft, to the hood, where they were disseminated over the roadway at a high temperature. This melted the snow and frost and heated the stone, and the asphalt was then poured immediately before the stone became cold. Heated chips were used to fill the voids in the first course and also on the top of the dressing.

We are indebted to J. T. Child, Winnetka, Ill., for this information.

The Glutrin-Bound Macadam Highway

By C. J. Knisely, Formerly Division Engineer, Ohio State Highway Department, before the Ohio Engineering Society.

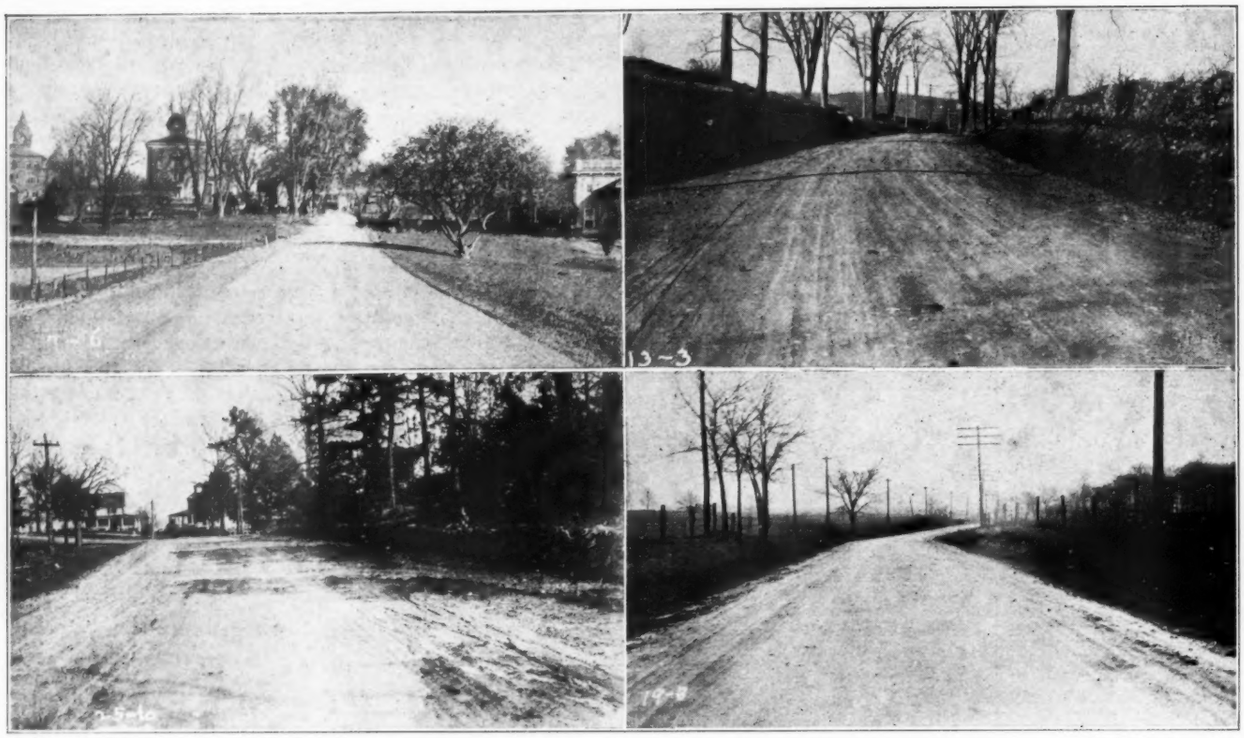
The ideal binder and preservative for a macadam road is some cementing material that will bind the aggregate firmly together. that will render the metal practically waterproof, form a stable surface and yet not destroy the elasticity and resilience of the mass. A binder that will protect the surface from the disrupting strains to which the road is likely to be subjected and at the same time will be reasonably low in first cost and economical to maintain.

The alinement, grade, earthwork, drainage, culverts and bridges of certain kinds, may be regarded as permanent parts of a road, but most of these will not remain permanent unless protected by a proper wearing surface. There is no such thing as a permanent road surface. Traffic and disintegration from natural causes render any road surface subject to repair or renewal at some time or other, and adequate provision should be made for such repair and renewals as the same may become necessary.

Some types of pavement may be cheaper than others in first cost, but their life may be shorter, or the annual expense of maintaining them greater. In other types the first cost may be excessive, which again renders the annual cost great, due to the annual interest charge upon the cost. The annual interest charge on the difference in cost may be greater than the annual cost of the maintenance of the cheaper type.

Most engineers are too prone to build expensive roads. They like to see what they term a finished product. It is better to make an entire country accessible by building a more universal means of communication and then letting the added prosperity maintain this up to a proper standard, than to leave part of it inaccessible by building only a limited number of miles of extravagant construction. The financing of road improvements is rapidly becoming of vast importance. It necessarily involves consideration of all future operations of construction, repair and maintenance, and the repair and maintenance charges should be considered at the time of selecting the type of pavement.

In the design of a road the engineer should consider the kind, nature and action of the forces or elements which tend



RED SHALE ROAD AT PRINCETON UNIVERSITY, NEW JERSEY; PROBABLY THE FIRST SUCCESSFUL SHALE ROAD BUILT IN THAT STATE, TREATED IN 1913.

SAND-CLAY ROAD AT CHAPEL HILL, N. C., TREATED IN FEBRUARY, 1912, ON INCLINE WITH CONSIDERABLE TRAFFIC AND NO SIDE DRAINAGE, WATER RUNNING DOWN CENTER. NOTE DIFFERENCE BETWEEN TREATED STRIP IN CENTER AND UNTREATED SIDES.

WILLIMANTIC-HARTFORD GRAVEL ROAD IN CONNECTICUT. SURFACE GLUTRIN TREATMENT IN JULY, 1913. NOTE HARDNESS AND FINE CONTOUR, AS SHOWN BY THE LINE SHADOWS ACROSS IT.

CHICAGO ROAD NEAR LAPORTE, IND. A BADLY RUTTED, RAVELED AND DUSTY MACADAM ROAD WAS TREATED WITH GLUTRIN IN SUMMER OF 1913 AT A LABOR COST OF ABOUT $12 A MILE, WITH THE EXCELLENT RESULT SHOWN, THE DUST BEING MADE A PART OF THE ROAD AGAIN.

to disrupt or disintegrate the road surface, and then select those materials and methods of construction, consistent with economy, which will best serve to counteract those forces.

The first essential is thoro drainage. The second is a firm, smooth, compacted roadbed. The road should be constructed in two courses. The lower course being designed to assist in distributing the loads over a larger area of the subgrade and to support the wearing surface.

Clays and most sub-soils when thoroly saturated with moisture, become very slippery. Therefore, if a roadbed is not properly drained and the voids are not thoroly filled, the traffic on a road will force the clay up thru the stone, where it will act as a lubricant between the particles of stone and the bearing or supporting value of the road will be destroyed. When a road surface is weak from insufficient thickness or from a soft or yielding foundation, bending and cross-breaking takes place under passing loads, which breaks the bonds between the stones.

The upper course should be designed to withstand the action of the elements and the wear and tear of traffic. The durability of a road surface depends upon the power of the materials of which it is composed to resist those natural and artificial forces which tend to destroy it. The stability of a macadam road surface depends largely on the interlocking of the pieces of stone and the retention of the fine particles of dust and screenings which serve to bind together and hold in place the coarser particles of stone constituting the road surface. The more perfect the keying and interlocking of the stone, and the binding of the dust and screenings, the more rigidity. This must be accomplished by chemical or mechanical means or both.

In the construction of a glutrin-bound road, it is very essential that all the voids be thoroly filled with screenings and fine dust, as the fine particles and screenings very materially assist in holding the larger fragments in place, and are also more readily acted upon by the glutrin. If the voids are not thoroly filled when the glutrin is applied, the road will act like a sieve and the glutrin will filter thru it before there is any action or set produced by it. Glutrin produces a firm, hard surface but has sufficient resilience and elasticity to withstand the strains due to changes in temperature without cracking.

There are in general use four different methods of binding the stone which forms the road surface. The first consists in keying and interlocking the stone by rolling and adding dust and screenings and flushing them into the voids. This forms a mechanical bond which assists in holding the pieces of stone in place. The second consists in adding to the stone or aggregate, a binder such as bitumen, the resulting bond being due to the adhesive action of the bitumen itself. The third consists of forming a bond between the various particles of aggregate by adding a material such as portland cement. When water is added to portland cement the active element of the portland cement immediately goes into solution, after which a precipitate is formed, consisting of crystals which in hardening adhere to the various fragments, thus binding them together. The precipitate which forms and hardens is the result of a chemical union between the cement and water, for the cement alone will not harden, unless moisture is added to it, nor has water itself any cementitious or binding properties. The fourth consists in using a material such as glutrin, and combining all three of the foregoing methods. In the process of laying, glutrin takes advantage of the mechanical action due to the interlocking of the stone, and it also has an adhesive

action similar to that of tar or asphalt, and a binding action like that obtained by the use of portland cement.

It has long been known that simple moisture has the effect of leaching out of road materials certain natural binders, chemically effecting a union between the particles of stone. A bond is developed by hydrolizing some of the rock components, which results in the formation of colloids. Water containing small amounts of carbonic, humus or other acids, is capable of slowly decomposing many materials commonly found in rocks used in road building. Water alone is capable of acting chemically upon many rock constituents, causing a breaking down into secondary products of the primary minerals. This is the principle underlying waterbound road construction and supplies what is known as the bond of a road. The chemical action acts in binding the road surface by the formation thru solution and evaporation of crystal bodies which upon crystallization forms a more or less rigid bond. The effect of glutrin is to intensify this leaching and hydrolizing action thereby greatly increasing the quantity and quality of the natural binder brought out of the road metal.

When glutrin is added to a road surface which is composed of limestone, silica and alumina, an action similar to that of portland cement takes place, altho its action is slower, producing a series of chemical compounds which flow out into the space between the stones and crystallize in very much the same manner as cement, forming a bond which is insoluble in water and which is not affected by changes in temperature.

Glutrin is not the only substance that acts chemically when applied to a road surface, as sodium silicate, commonly known as water glass, and having the formula $Na_2 SiO_3$, upon exposure to the air or to carbonic acid gas, precipitates gelatinous silicic acid from its solution, which when applied with some basic material, such as ilmestone, makes an excellent binding material. Sodium silicate may be applied in solution. From solutions of metallic salts, sodium silicate precipitates insoluble colloidal silicates of the metals.

The life of a glutrin road is dependent largely upon the aggregate used and the methods employed in the construction. As long as there is moisture present, the production of the chemical bond continues and when the road becomes dry the bonding medium created by the action of glutrin hardens and becomes insoluble. The voids thus become so sealed that the surface thereafter absorbs but very little moisture. The adhesive action is intensified, thereby obviating all raveling of the road surface, greatly reducing the wear upon the road because of the hardness and density of the mass which it produces. Some binders produce a very rigid bond and others a more or less resilient bond. The latter is to be preferred for country highways.

Another point to be considered in the selection of a road surface for country highways is that the traffic confines itself to about three-fourths of the width of the road. Where the traffic is heavy or concentrated, there is a marked tendency for bituminous macadam of the penetration type to squeeze out, forming broad depressions, holes and ruts, owing to the bitumen possessing very little inherent strength to resist shear and compression. These depressions will eventually become deep enough to collect debris and hold water which will hasten the deterioration of the road. On city and village streets this tendency is not so great, as the traffic must necessarily be well distributed over the surface and in diagonal directions because of the constant passing of the various vehicles. The problems involved in the construction and maintenance of country highways, therefore, differ very materially from those which are encountered in the improvement and maintenance of city streets. Hence, the materials and methods of construction which have proven satisfactory for city and village streets, often prove dismal failures in country highway construction.

The object of a surface treatment is to prevent the formation of dust, the loss of the fine particles and the displacement of the coarse aggregate. A clean, practically dustless surface is the first requisite of any form of surface treatment; since it is not the purpose of a surface treatment to lay any quantity of dust which may be present on the road, but to prevent the formation of dust. Many so-called road binders are essentially lubricants and when put on a road surface in any considerable amount will disintegrate the road surface instead of binding it. It is very desirable and important that the surfacing material penetrate the surface of the road to a small extent.

A difficulty with most surface treatments is that they form a mat or carpet coat on the road surface which does not adhere to the road metal. This mat soon breaks and peels off and instead of protecting the road surface, is a serious detriment or damage to it, as the traffic produces a hammering effect upon the road metal where the mat has been displaced, causing deep holes and ruts.

It is generally conceded that asphalt is best for surface treatment for bituminous roads. This is best evidenced by the action of the American Society of Municipal Improvements at their convention held in Dayton in October last, when they, by their action, recommended an asphalt surface for all types of bituminous road construction. whether the bonding material be of asphalt, tar or other bituminous product.

A serious objection to most binders by the penetration method is that in cold weather they become brittle and slippery, while in warm weather the road loses much of its stability due to the plastic condition of the bitumen and to the fact that the voids are mostly filled with bitumen instead of screenings and fine graduated material.

Usually the best results have been obtained by the application of cold asphalt treatments. It is advisable to wet the road and let it set until thoroly dry before application. This cleans the stone, thereby removing any film of dust and also makes the surface slightly porous. The resulting moisture induces capillary attraction and offers a better chance for the bituminous material to penetrate and adhere to the road surface.

On roads where the products of wear and dust formation are reduced to a minimum, the road may become dusty from outside sources, as no road surface will remain dustless for any considerable length of time.

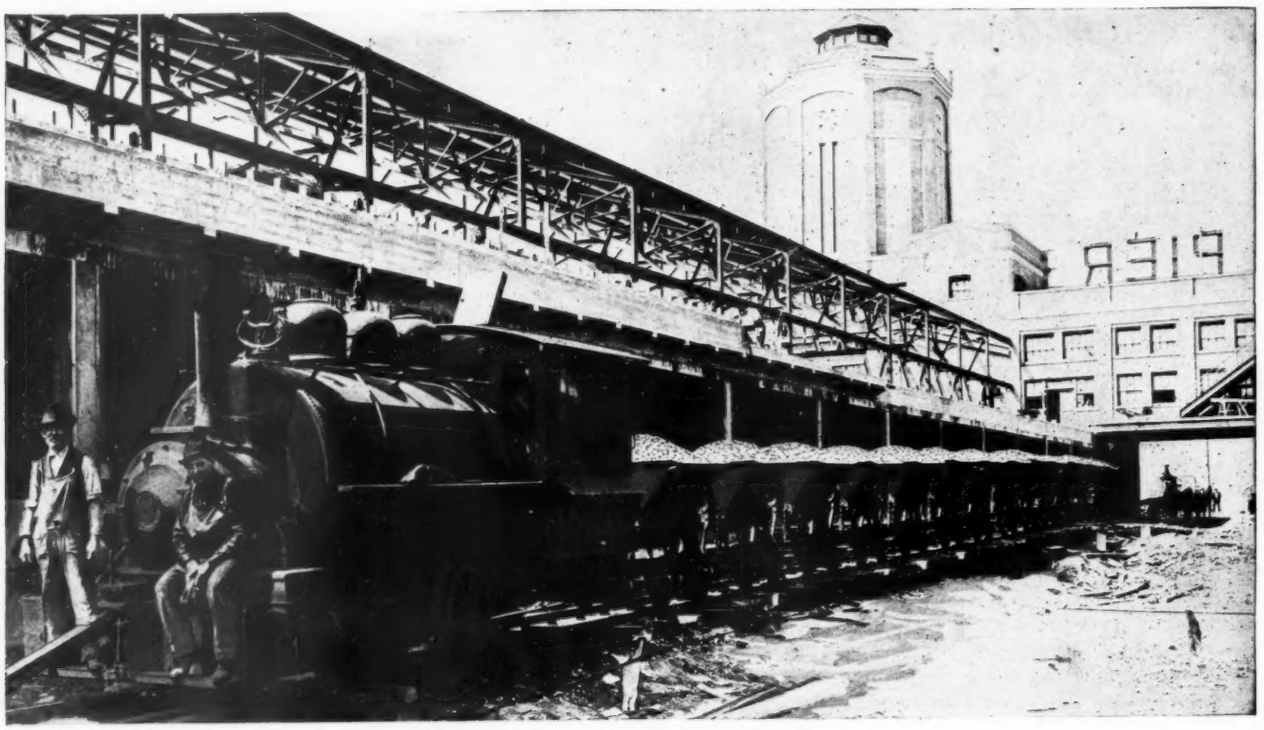
The ideal road surface for highways for cities and villages is a macadam road bound with glutrin, and treated with a light asphalt. The glutrin binds the aggregate together, forming a very stable surface. The asphalt combines with the glutrin, forming a chemical or mechanical mixture, insoluble in water and which produces a dustless surface that will not crack, break or peel off.

A glutrin macadam, properly constructed and maintained comes nearer fulfilling the ideal conditions for a street or highway than any other type. It is comparatively quiet. It has low tractive resistance. The first cost is low. It is economical to maintain. It is easy to construct and repair. It is not affected by frost, rain or wind. It affords a good foothold for horses and is not displaced by heavy loads or auto traffic. It is practically dustless and is easily cleaned. It radiates but little heat. It is pleasing to the eye and adapted to every grade.

Chicago's Municipal Pier

By L. A. Dumond.

Chicago's new recreation, or municipal pier, located on the north bank at the mouth of the river, extends for a distance of 3,000 feet into the lake. The pier proper, which is 300 feet in width, was made by constructing large concrete walls resting upon piles driven into the bed of the lake, and filling in the intervening space with sand and excavation of all kinds collected within the city.



LAKEWOOD ONE AND ONE-HALF YARD "V" DUMP CARS HAULED IN TRAINS HANDLING SAND AND CRUSHED STONE ON CHICAGO'S NEW RECREATION PIER.

Beginning at the shore end of the pier, the first building which meets the view is the head house, which is distinguished by two octagonal towers. This building will house the administrative officers, who will look after the various municipal and commercial interests making use of the pier.

From the head house to the terminal building, 2,340 feet in length, stretch two freight and passenger buildings with an 80-foot roadway in the center.

The first floor of these buildings, which are 2-story structures, will be devoted to the handling of the freight and package business carried on by the many steamship lines entering the port of Chicago. The roadway, already mentioned, will permit freight to be loaded and unloaded but a short distance from the boats docked at the pier and on a level with this floor. The floor for freight handling in each of these buildings is 100 feet in width, with 6-foot docks for loading purposes.

The second floor of these buildings is designed to accommodate the passenger service of large excursion or passenger boats. Passengers may embark directly from this floor upon the boats. The floor is 67 feet in width, with 16-foot passageways upon the outer side of each building.

Office space is also provided upon the second floor ample for all steamship lines making use of the freight and passenger facilities offered at the pier.

Street cars from the Grand avenue line enter the buildings upon the level of the second floor, running adjacent to the inner edge of this floor and extending thruout the entire length of the buildings with a return loop to the city.

Above the roof of the freight and passenger buildings and surrounding the same on the outer side is a railroad promenade 14 feet in width, which extends past the terminal building and above the roofed shelter, to the concert and dance hall located at the extreme end of the pier.

In the space between the terminal building and the concert and dance hall, about 115 feet in length, is provided a 2-story roofed shelter open at the sides. This space is for the exclusive use of the public for recreational purposes and will be available for use day and night. The immense shelter will be equipped with tables and chairs, and will really constitute two large roof gardens where one may rest and recuperate in the cool of the lake, removed from the rush and roar of Chicago's busy center. It is intended that no charge shall be made for its use.

This municipal auditorium has a floor space of 18,000 square feet, and is provided with a stage suitable for dramatic entertainments, band concerts and like functions. The hall will seat about 4,000 people, and can be used for small conventions, public meetings, etc. It will also provide an ideal place for the holding of dances. The present intention is to make no charge to the public for its use.

In addition to the civic and commercial functions which will be served by the new pier, the government has found it to be a good location for a signal station, which it has built at the extreme eastern end and is now operating.

The municipal pier, when completed, will represent an expenditure of about $4,600,000, all of which has been provided by a bond issue voted by the people of Chicago. It is estimated that the income from the rental of space in the freight and passenger buildings and the other concessions will pay for the maintenance of all the buildings, amortize the original cost and pay 4 per cent. on the investment.

The pier is well protected by a government breakwater on the north side. A small gap in this breakwater is now being closed. To add to its safety in time of a storm, a breakwater is now under construction south of the mouth of the river. This breakwater now extends to about the foot of Randolph street. A government appropriation is assured, which will enable the breakwater to be extended as far south as Adams street.

MISCELLANEOUS

The March of Events

June 3. The Municipal Engineers of the City of New York have the unusual privilege of inspection of the fortifications at Sandy Hook.

June 5-7, at Cleveland, O., National Conference on City Planning. Flavel Shurtleff, secretary, 19 Congress street, Boston, Mass.

June 13, 14, at Ogden, Utah, Intermountain Good Roads Association. O. J. Stillwell, secretary, Ogden, Utah.

June 5-9, at New York City. American Water Works Association. J. M. Diven, secretary, 47 State street, Troy, N. Y.

June 6-9, at Newark, N. J., International Association of Chiefs of Police. Chas. Kiser, secretary, Norfolk, Va.

June 14-17, at Cleveland, O., American Institute of Chemical Engineers. I. C. Olsen, secretary, Cooper Union, New York City.

June 15. The Municipal Engineers of the City of New York, The Brooklyn Engineers' Club and The American Society of Mechanical Engineers will spend the evening on the steamer Mandalay on the Hudson river, with a moonlight sail and dance.

June 21-23, at Isle of Pines, S. C., Tri-State Water and Light Association of the Carolinas and Georgia. W. F. Stieglitz, secretary, Columbia, S. C.

June 25-30, at Philadelphia, Pa., Associated Advertising Clubs of the World. P. S. Florea, secretary, 803 Merchants Bank building, Indianapolis, Ind.

June 29, at Chicago, Ill., National Gas Engine Association. H. R. Brate, secretary, Lakemont, N. Y.

June 27-30, at Pittsburg, Pa., American Society of Civil Engineers. Charles Warren Hunt, secretary, 220 West 57th street, New York City.

June 27-30, at Atlantic City, N. J., American Society for Testing Materials. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

June 19-22, at Pittsburg, Pa., Society for the Promotion of Engineering Education. F. L. Bishop, secretary, University of Pittsburg, Pittsburg, Pa.

June 20-22, at Wilmington, N. C., North Carolina Good Roads Association. Dr. Joseph Hyde Pratt, secretary, Chapel Hill, N. C.

Sept. 4-8, at Lexington, Ky., Southern Appalachian Good Roads Association. Dr. Joseph Hyde Pratt, secretary, Chapel Hill, N. C.

Sept. 19-20, at Santa Barbara, Cal., Pacific Coast Gas Association. Henry Bostwick, secretary, San Francisco, Cal.

Sept. 18-20, at Philadelphia, Pa., Illuminating Engineers' Society. Jos. Langan, secretary, 29 West 39th street, New York City.

Oct. 2-6, at Grand Rapids, Mich., Playground and Recreation Association of America. H. S. Vaucher, secretary, 1 Madison avenue, New York.

Oct. 9-13, at Robert Treat Hotel, Newark, N. J., American Society of Municipal Improvements. Chas. C. Brown, secretary, 702 Wulsin building, Indianapolis, Ind.

Dec. 5, at Chicago, Ill., United States Metal Culvert Association. A. W. Dowlers, secretary, 1102 Tacoma building, Chicago, Ill.

Dec. 6-8, at Washington, D. C., National Rivers and Harbors Congress. S. A. Thompson, secretary, 824 Colorado building, Washington, D. C.

Feb. 5, 1917, at Boston, Mass., American Road Builders' Association and Road Congress. E. L. Powers, secretary, 150 Nassau street, New York.

An Acknowledgement

In connection with the article on the "Municipal Asphalt Plant of Manhattan Boro," in the May number of MUNICIPAL ENGINEERING, credit for the data was inadvertently omitted. The material in the article appeared, much of it, in a paper on the plant before the Municipal Engineers of the city of New York, by William Goldsmith, construction engineer.

Chicago Preparedness Parade

Following the great preparedness parade in New York, which marched for thirteen hours to pass a given spot, is the Chicago parade of June 3, which promises, as this is written, to be equally great, and has doubtless demonstrated it by the time this is read. Eighteen engineers' organizations are represented in the committee and the indications are that several thousand individual engineers will appear in the engineers' section, headed by the Naval Consulting Board.

The weekly meetings and drills of engineers are well attended and the lectures are of absorbing interest. At the meeting of May 25, Ernest McCullough, who has had twenty years of experience in the National Guard, advancing to the rank of major, gave an illustrated lecture on modern field pieces and the work of batteries in the field, with an explanation of the mathematical problems involved in accurate marksmanship with cannon of various designs. At the meeting June 1, Philip Sampson, of Chicago, invalided back to Canada as the place of his enlistment, gives a story of his experiences in the Canadian contingent in training and in war. Captain H. B. Sauerman reads a paper on field fortifications, and Captain L. S. Marsh gives instruction on patrolling. These are samples of the weekly work of the Chicago Committee on Military Engineering.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

June 7, 8: Mining draftsman in Bureau of Mines, Pittsburg, Pa., at $1,200 a year.

June 7, 8: Aid in Coast and Geodetic Survey, beginning at $900 a year.

June 13: Expert radio aids in machinery division, Mare Island Navy Yard, California, and department of steam engineering, Navy Yard, Washington, D. C., at $6 a day.

June 13: Mineral technologist, in Bureau of Mines, Washington, D. C., and in field at $2,400 to $3,600 a year.

June 20: Metal mining engineer in Bureau of Mines, in the field, at $2,400 to $4,000 a year.

June 21: Assistant physicist, qualified in spectroscopy, in Bureau of Standards, Washington, D. C., at $1,400 to $1,800 a year.

June 21: Master mechanic in forge shop, naval gun factory, Navy Yard, Washington, D. C., at $7.44 a day.

June 21: Junior electrical engineer, Bureau of Mines, at Pittsburg, Pa., at $960 to $1,200 a year.

July 5: Assistant sanitary engineer in Public Health Service, at $1,600 a year.

Technical Schools

The extension division of the Portland Cement Association will hold a short course in concrete for manual training and vocational teachers, at Lewis Institute, Chicago, June 26 to July 1.

The latest bulletin of the Engineering Experiment Station of the University of Illinois are No. 84, on "Tests of Reinforced Concrete Flat Slab Structure," by Prof. A. N. Talbot and W. A. Slater, and No. 85, on "The Strength and Stiffness of Steel Under Biaxial Loading," by Albert J. Becker. W. F. M. Goss, Director, Urbana, Ill.

A recent bulletin of the University of Michigan makes general announcement of the courses of study of the colleges of engineering and architecture for 1916-17 in about 200 pages of text.

The Municipal University of Akorn, O., issues the announcement for 1916-17 of its college of engineering, which is operated on the Cincinnati University co-operative plan. The work next year covers three of the five years of the full course.

Personal Notes

Paul Riston has been elected city engineer of Punxsutawney, Pa.

Joseph W. Hunter, long connected with the Pennsylvania State Highway Department, is acting commissioner on account of the death of Commissioner Robert J. Cunningham.

Herbert C. Keith, consulting engineer in bridge and structural work, masonry, foundations, railroads and legal engineering, has moved his offices to the Tribune building, 154 Nassau street, New York.

Caleb Berry is the city engineer of Centralia, Wash.

I. B. Funk is the new city engineer of Newport Beach, Cal.

Charles E. Hewes has been given the duties of city manager of Alhambra, Cal., in addition to those of city engineer, which he has been performing.

Henry Rohwer, graduate of German universities and well known engineer on railroad location and construction and as chief engineer of the Gould system, died in St. Louis, May 4. Some of his earlier work was municipal, as city engineer of Omaha in 1877 to 1881. He was one of the earliest advocates of good roads in Missouri and was prominent in the first good roads meeting in that state in 1893.

Geo. H. Randall is city engineer of Oshkosh, Wis.

Andrew F. Macallum, who has been city engineer at Hamilton, Ont., for about seven years, goes, this month, to Ottawa as commissioner of works. Mr. Macallum's experience at Hamilton has been quite large and varied, as he has spent over a million dollars rebuilding the water works system, has built trunk sewer systems for the east and west ends of the city, and a sewage disposal plant for the west end, also about 22 miles of permanent pavements by day labor, including a new municipal asphalt plant. Before his employment at Hamilton, he was connected with water, sewer and other municipal work in several Canadian cities, for a number of which he is and has been consulting engineer. His experience also includes railroad work all the way along the line, including chief engineer. Mr. Macallum is a member of both the American and Canadian Societies of Civil Engineers and is the president of the American Society of Municipal Improvements, of which he will be the presiding officer at the Newark convention next fall. He is a graduate of the University of Toronto. Mr. Macallum takes to his new work a ripe experience and his competency has been especially recognized by his professional brethren, as indicated by the honors they have conferred upon him.

William Powrie, city engineer of Waukesha, Wis., is now also president of the board of public works.

James Allen, formerly chief engineer of the Washington State Highway Department, has been appointed State Highway Commissioner.

Stanley H. Rose, until recently in charge of the New York office of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, has been engaged by the Barber Asphalt Paving Co. to direct its foreign trade department. Prior to his appointment as commercial agent of the bureau, Mr. Rose had had an extensive business experience in the larger part of Europe, Australia, New Zealand, India and Egypt, and had also held important posts with American and European firms engaged in foreign trade. He is considered an expert in foreign tariffs, trade regulations and shipping. As special agent of the Bureau of Foreign and Domestic Commerce, Mr. Rose has just completed a tour of more than fifty cities of the Middle West, South and Southwest, acquainting manufacturers with foreign trade opportunities and advising commercial organizations as to the best methods of promoting export trade. Mr. Rose was educated in London, Berlin, Paris and Brussels, and speaks most of the modern languages. The Barber Company's export trade in paving materials, roofing and other asphaltic products will hereafter be in Mr. Rose's charge, with headquarters in Philadelphia and New York.

Lester Kirshbraun, consulting engineer, Chicago, Ill., will supervise the construction of pavements in Beloit, Wis., during the season of 1916.

L. A. Nicholson is the new city engineer of Tacoma, Wash.

Earl A. Zeisloft is city engineer of Akron, O.

T. L. Higgs has been appointed city engineer at Parkersburg, W. Va.

Joseph M. Tracey is city engineer of Ogden, Utah.

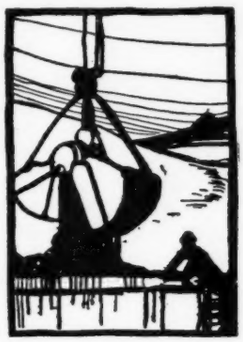
Charles W. Gossart is boro engineer of Kutztown, Pa.

G. N. Adams is the new city engineer of Tropico, Cal.

Albert Wostenholme has been promoted to city engineer of Fall River, Mass.

Edward R. Stapley is resident engineer for Wilson, N. C., which has nearly $500,000 of improvements under construction.

Charles Cottingham, consulting engineer, Danville, Ill., has moved his office to the Daniel building.



MACHINERY AND SUPPLIES

Ten Years of the Motor Tractor

Fifteen years ago at the opening of the present century, the steam tractor had reached its fullest development and steam tractors had become a common sight in all sections of the country doing the many kinds of work to which a tractor could be adopted. During the last ten years of the nineteenth century it had taken its place as one of the country's indispensable machines and yet today it has almost disappeared.

When the gasoline or kerosene motor had been fully developed and applied to a tractor its superiority over the steam tractor was so obvious and was so quickly recognized that the use of the steam tractor simply faded away.

In a recent issue of the *Farm Implement News*, devoted to the tractor industry, there is given a tractor directory in which are listed alphabetically by name one hundred and forty-six tractors. Everyone of them is a gas or motor tractor and there is not a steam tractor in the whole list.

There is only one modification to the above sweeping statement and that is as it applies indirectly to the steam roller. A roller is mainly a tractor with heavy wheels. Much of the work required of it is exactly similar to that of any other kind of tractor and the reasons for abandoning the steam tractor in favor of the gas tractor apply with equal force to abolishing the steam roller in favor of the motor roller so far as such use is concerned.

Ten years ago there was not a motor roller in America. The first one built in this country was the Austin motor roller of the Austin-Western Road Machinery Co. Since then its sales, both actual and relative, have increased annually by leaps and bounds until today a very large percentage of all power rollers made in this country are motor rollers and probably ninety per cent of the motor rollers are Austin rollers.

Portable Steel Clam-Shell Tractor

We are illustrating a Byers No. 331 baby excavator as used for unloading gondola cars. This outfit has also been used for digging sewers, back-filling trenches, etc.

The frame is constructed of heavy section deep steel channels, cross-braced and trussed.

The car body is 15 feet long by 6½ feet wide; width of outside wheels (forward and rear wheels track) 9½ feet; wheel base 13 feet; height from ground to top of A frame 12 feet; boom easily lowered and stack removed for close clearance; width of outside outriggers, folding, 18 feet; size of bucket to use, ½-yd. clam shell or 1/3-yd. orange peel; length of boom, 20 feet for heavy bucket, 26 feet for light bucket; weight complete without bucket, 19,000 lbs.

For sand, gravel, screenings small coal and similar loose material, almost any light standard bucket does well. But in 1-in. or 3-in. crushed rock, slag and such dense interlocking materials, it is very important to have a high-powered bucket and sometimes even the addition of teeth. Consequently it is very important to have a bucket adapted to the service, as otherwise results may be very disappointing.

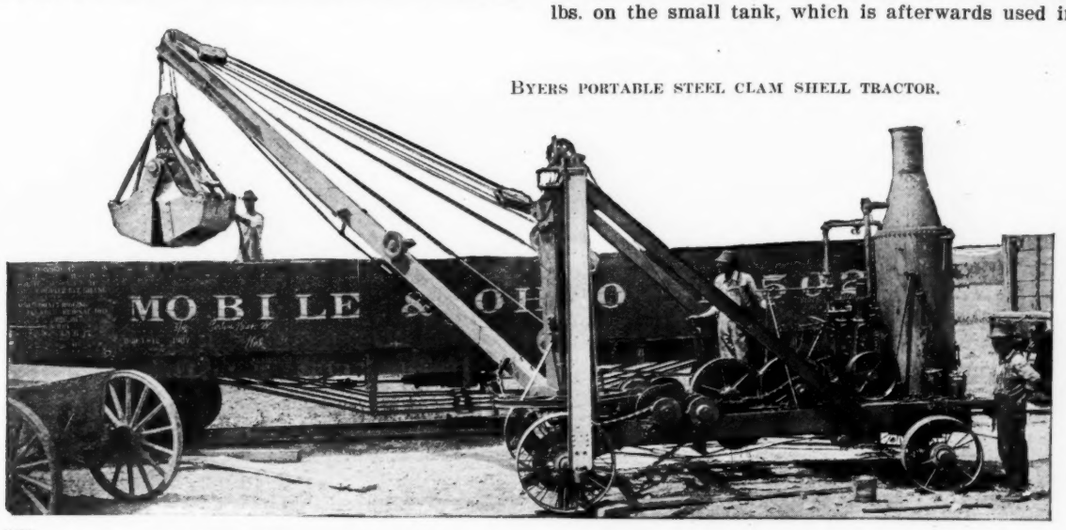
This outfit is manufactured by the John F. Byers Machine Co,. Ravenna, O.

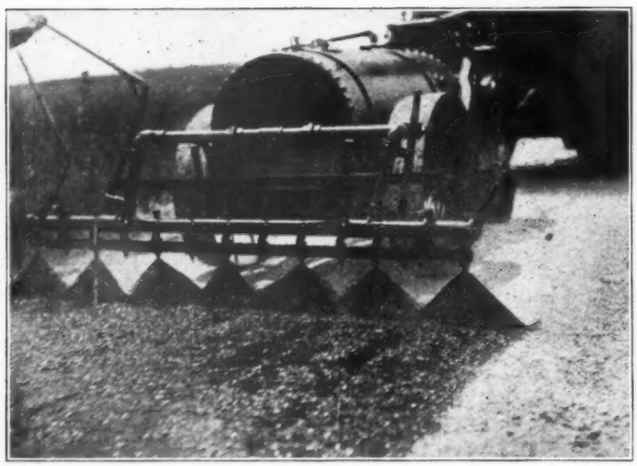
Tarrant Oil Distributer.

The Tarrant Manufacturing Co., Saratoga Springs, N. Y., are marketing two pressure oil distributers.

The smaller one is of 100 gallons capacity. This outfit is equipped with a gasoline engine and air compressor mounted on a separate truck, which, during the interval of filling the machine with oil, pumps up an air pressure of 100 lbs. on the small tank, which is afterwards used in distribut-

BYERS PORTABLE STEEL CLAM SHELL TRACTOR.





TARRANT OIL DISTRIBUTER APPLYING SQUEEGEE COAT OF ONE-HALF GALLON PER SQUARE YARD.

ing the oil from the larger tank. This machine is mounted on two wheels, weighs approximately 1,600 lbs. when filled with oil, spreads 8 ft. wide, and, while we recommend a mechanical haul for the purpose of getting an even distribution, it can be horse-drawn.

On both of the Tarrant machines the distributer swings horizontally when in use. The advantage of this feature is to keep the distribution even on the road surface even tho the roller man can not drive his roller in a straight line. It fills the skips and bare places left in the road, which is only possible with these machines.

The larger machine, illustrated, is of 200-gallon capacity, weighs approximately 2,500 lbs. when full, spreads 8 ft. wide, is equipped with a two-cylinder steam driven air compressor which is driven by steam from the roller and furnishes the air for distributing the oil. The photograph shows this machine spreading an 8 ft. strip of one-half gallon to the yard, and, as these photographs are untouched they show very plainly what the machine can do.

Novaculite for Street and Road Construction

Novaculite is an uncrystalized quartzite, being 98 per cent silica, and entirely free from lime or other alkaline substances. It is very much like flint, and occurs in large quantities in Southern Illinois and Missouri, and at many places in Arkansas; some forms of it are used for razor hones. As usually found in these localities, it forms the undecayed portions of a porphyritic formation belonging to the unstratified or primitive rocks, in conjunction with the granites. The softer ingredients of this formation have degenerated or decayed, leaving the silicious portions in a very much broken up condition, more or less uniformly dispersed in a cement like matrix, or bonding material, which is the decayed remains of the less permanent ingredients of the primitive rock, and is spoken of as "the bond."

This quartz, or Novaculite rock, is the hardest of rocks; it scratches glass like a diamond. It resists all disintegrating action of the weather when exposed for long ages, as is evidenced by the sharp outlines of the exposed tops of the quarry hills. Hundreds of thousands of years of exposure to the elements have not rounded or worn away the sharp angles and corners still exposed to these disintegrating influences. A Novaculite fragment with corners rounded by exposure does not exist.

While this material is quite common in Missouri and Arkansas, it seldom is mixed with just the proper proportions of bonding material to adapt it for paving purposes. In Illinois quarries, however, it forms 90 per cent. of the whole, leaving just enough of the bond to cement it into an absolutely solid and impervious mass, very much like cement concrete. It differs from concrete, however, inasmuch as when the bond is broken it will form again on a thoro rolling or ramming; whereas cement concrete is brittle, and when once cracked or broken it cannot be again united.

The Novaculite portion is found very much broken up into sharp angular masses, from the smallest visible particle to lumps of several cubic feet in size. All these large lumps, however, are very much cracked and easily broken into fragments by a few blows of a sledge or hamer.

The city of Cairo, Ill., first used Novaculite in the construction of streets some 25 years ago, and a number of the original streets are still in use; very little spent on them in maintenance, and in fairly good condition considering the length of service. This city constructed two new districts this season, which would seem to indicate that Novaculite has proven satisfactory to them. Geo. F. Dewey is the city engineer.

Novaculite was used to a large extent in the construction of the highways of Madison County, Tenn., these roads having been in service 13 years. Large quantities have been used for road construction in Lee, Monroe, Chickasaw, Clay, Lowndes, Lauderdale and Warren counties, Mississippi. The highways in Lauderdale and Warren counties have been pronounced the best in the south. Novaculite has also been used for street construction in Fulton, Ky., Union City, Trenton, Jackson, Ripley and Dyersburg, Tenn., and Tupelo and Meridian, Miss.

Novaculite was used in the construction of the mile of road constructed under the State-Aid at Hodges Park, Ills., last year. The material was straight run of the quarry for the base, and Nos. 2 and 3 sizes mixed used for the top, with a small amount of No. 3, the small size, used for touching up any places that appeared coarse. The roadway proper is in good condition, altho better results might have been secured had No. 1 or coarse size been used for the base instead of the pit run. The earth shoulders on this road show some wash from rains, the soil being of a sandy nature, and now require some attention. About three more miles of road adjoining this one will be let in June. B. H. Piepmeier is the maintenance engineer for the State Highway Department.

Kreolite End-Lug Grooved Blocks

By W. E. Wright.

The design of Kreolite end-lug grooved blocks, for flooring, is intended to retard the effects of expansion and contraction under varying conditions.

Government experts have shown that the shrinkage of untreated southern yellow pine, from the green to the kiln-dried state, may amount to 10 per cent. of its volume—about 2½ per cent. along the radius and about 7½ per cent. along the tangent to the yellow growth rings.

An examination of the growth rings of ordinary rectangular creosoted wood paving blocks will disclose the fact that nearly nine-tenths of all blocks are manufactured so that the maximum tangential shrinkage or expansion will occur. Very few rectangular blocks have the heart "boxed in", so that but few blocks exert the lower radial variations as to volume.

The function of the groove of the Kreolite end-lug grooved block is to destroy the peripheral tension of the annual growth

FIG. 1. FIG. 2. FIG. 3.

rings, by exposing the inner rings to the air so that they may dry and shrink with the same degree of rapidity as the exterior growth rings. Three grooves or notches, extending into the wood about ¼ inch, are placed on one side of each block, so that one groove will under all conditions break the continuity of the annual growth rings, the entire depth of the block, at, or near, the point of tangency to the side of the block. The grooves in the side of the block convert the greater tangential variation in volume to the lesser form of radial shrinkage or expansion. The groove, therefore, retards to a very great degree the tendency of the block to shrink.

Figures 1, 2 and 3 show blocks cut from different portions of the cross section of a tree, demonstrating that one of the grooves will break the annual growth rings at, or very near to, the point of tangency with the side of the block.

The wedge-shaped or pointed lug of the Kreolite end grooved block is an integral part of the wood, placed in the center of one end and extending the full depth of each block, and protruding therefrom ¼ inch. As the wood swells or expands, the lugs compress, providing a uniform, individual expansion joint for each block, preventing damage due to expansion.

The grooves are also wide enough to permit a bituminous filler to penetrate the full depth of the blocks, even when laid up closely, thus binding them more efficiently into a solid, wearing surface.

Segment Culvert Blocks

Vitrified segmental blocks, which have been quite extensively used the last two or three years in sewer construction, are being introduced for highway culverts, particularly in the clay country of the Middle West. The accompanying illustration shows an 84-in. culvert in Kansas which was built by two inexperienced men and a helper in one working day's time. The arch centers used for this work were merely three templets cut to a 24-in. radius and wedged up on 4x4-in. sticks placed across the culvert just below the springing line. The templets were covered with 1x4-in. strips. On completion of a section of the arch the wedges and centering were removed and backfilling proceeded at once, without waiting for the mortar to set. Adjacent blocks are dovetailed to prevent their being

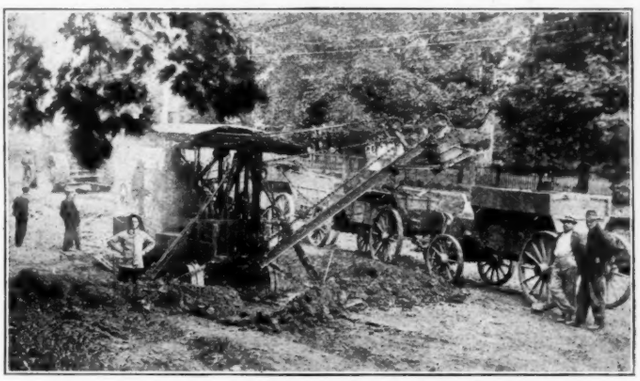
LARGE HIGHWAY CULVERT OF SEGMENTAL BLOCKS.

displaced. These blocks are manufactured by the W. S. Dickey Clay Manufacturing Co., Kansas City, Mo.

Segment block for culvert purposes solve the problem of large culverts at low cost. The culverts, for instance in Johnson Co., Kan., cost slightly over $100 and will replace a $200 bridge. A culvert of this kind can be constructed rapidly and simply, backfilling commenced immediately upon the completion of the arch and the road used at once. They will hold up a great deal of weight and with ordinary care and backfilling cannot be broken down. Head walls are necessary on all culverts to hold the road grade in place and they are advocated on segment block culverts, altho they have been laid without head walls very satisfactorily.

Keystone Traction Excavator

The Keystone Driller Co., Beaver Falls, Pa., are marketing a traction excavator which can be used as a light, portable general utility steam shovel, in conjunction with a dipper scoop. It will take down and load into dump cars or wagons a bank 12 feet high (or higher if the material will cave or can be shot down when undercut). The regular size of dipper scoop used holds ½ cu. yd. The boom being 16 feet long, the material can be taken up from any point and loaded upon dump wagons at any point within a half circle 32 feet in diameter. Material of the hardness of water slates, soft rock, and boulders as much as 24 inches thru can be handled. The speed of operation depends somewhat on the skill of the operator but an average speed would be 20 to 30 dump wagons per hour.



KEYSTONE EXCAVATOR GRADING ROAD WITH SKIMMER SCOOP AT ROCHESTER, N. Y.

This novel outfit may also be used as a dirt loader and grader. When so used it will take up from a few inches to 5 or 6 feet of material and leave a smooth surface at any desired grade or slope. It will load sand, gravel or clay, and boulders up to 20 inches or more in diameter.

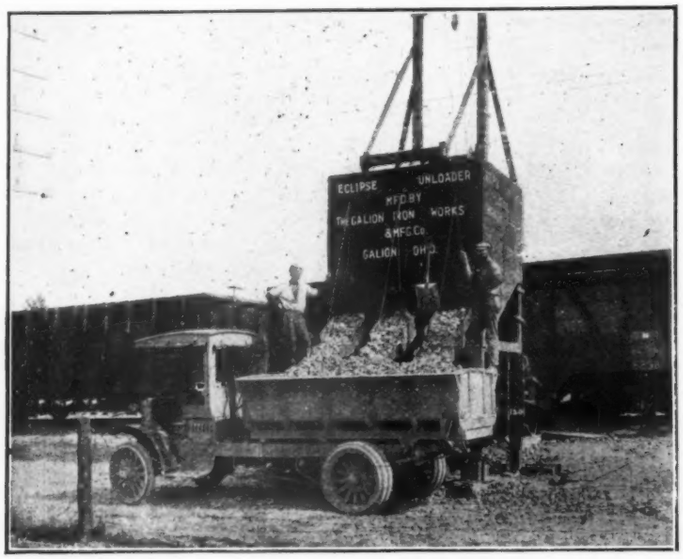
The skimmer scoop, which is the one best adapted for this work, holds about ½ yard. It will readily cut and take up any material which would otherwise be broken by a plow (not rooter). Used in the center of a street not over 30 feet wide, it will grade and load from curb to curb, loading to either side of the machine at will. It will load 15 to 30 dump wagons per hour, owing somewhat to the nature and depth of material to be excavated. The skimmer scoop is 31 inches wide.

When used as ditch digger, the machine is backed away from, and in line with the center of the ditch being made, 7 or 8 feet at a time. In fair material it will excavate to a depth of 10 or 11 feet, depositing the material to either side of the ditch, either on the ground or in dump cars. It can also be used for cellar digging or making narrow cuts within the above depth limit.

Galion Eclipse Portable Loader

The chief units of this outfit consist of the frame, the hoisting apparatus, the bin, the chute and pit, and the power plant.

The Eclipse is first located at a siding and the cars are so moved that the hoppers or slides are over a chute placed under the track thru which the load is discharged into a bucket in a pit which is between the elevator and the track. The bucket is loaded and then hoisted on an inclined track and emptied at the top of the track into a hopper bin, from which it is discharged by gravity thru chutes into wagons, trucks or hauling cars that are driven beside the elevator, three chutes so distributing the loads that trimming is unnecessary. The drivers operate the chutes and load their wagons without delay or assistance.



GALION ECLIPSE PORTABLE LOADER.

The removal of the unloader from one location to another is extremely simple. The track is hoisted from the pit and folded; the tower is demounted and lowered; the side sections of the bin are lowered; the supporting posts are raised on their hinges; trucks are placed under supporting frame, and the unloader can then be easily hauled by a team, truck or road roller.

The safety device which eliminates all possible chance of injury to railway employes and all who have occasion to walk over the chute, operates automatically, as follows:

When ready to unload a car of material, the car is so placed that the hopper in the bottom is directly over the chute; the lock holding the safety cover of the steel chute is released, the gate in the bottom of the car is opened and the weight of the material forces the cover down inside of the steel undertrack chute so that the cover lies flat on the inclined bottom of the chute, in which position it remains until the car and the under-track are empty of material.

As soon as the car is empty and all of the material in it has been emptied into the bucket to be hoisted into the bin, a powerful spring raises the safety cover to its normal position, flush with the top of the two railroad ties, between which the under-track chute is located. The safety cover is automatically locked in this closed position and cannot be opened until the lock is released.

146 Road Rollers Ordered by One Customer

One of the most remarkable events in the road-roller manufacturing business has just occurred in the purchase of 146 road rollers by the Russian government from the Austin Manufacturing Company, Chicago. This order is, without doubt, the largest ever placed in the history of road rollers, either in this country or any other country.

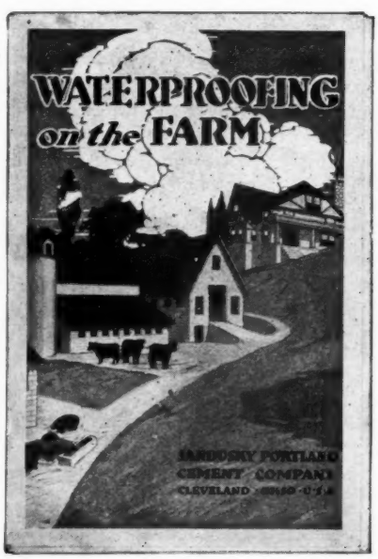
The heading for this article is perhaps modest in that it only refers to the orders placed in April, 1916. As a matter of fact, the Russian government have owned and operated about fifty Austin rollers for a number of years. It can be attributed to the latter fact that this recent magnificent order has been placed with the same concern. The machines are ordered in three different sizes, 8-ton, 10-ton and 12-ton; they are equipped to operate on Russian kerosene oil, the product of the vast oil fields located in southern Russia.

The history of the Austin motor roller has been spectacular. Nine years ago they put their first machine on the market and probably no piece of machinery connected with engineering construction work has ever created so much excitement amongst competing manufacturers, or attracted so much attention from the road building public using road rollers.

The Austin roller was the first motor-driven machine placed on the market in the United States, and it was only natural for it to create tremendous opposition from the old established steam roller manufacturers, who had believed themselves securely entrenched in a market of their own. The opposition to the machine, however, was confined to those interests. It is to the credit of the American road building public that the Austin motor roller got a splendid reception from the very start. The exceptional advantages and improvements it offered were quickly appreciated, and the machines were adopted very rapidly by all sections of the country. In fact, for the first few years after its introduction, the purchases were limited only by the capacity of the Austin shops to build the machines. These shops have been added to four times in the nine years until they are now undoubtedly the largest and most perfectly equipped in the world devoted to road rollers and road making machinery.

If there ever was a foundation to the doubts expressed about the practicability of the Austin motor roller when it first appeared on the market, that foundation has been proved false and been swept away by the enormous success which the roller has met with in every part of the world, and this impressive order for such a large number of machines, is one that all American manufacturers must be proud of.

Waterproofing on the Farm



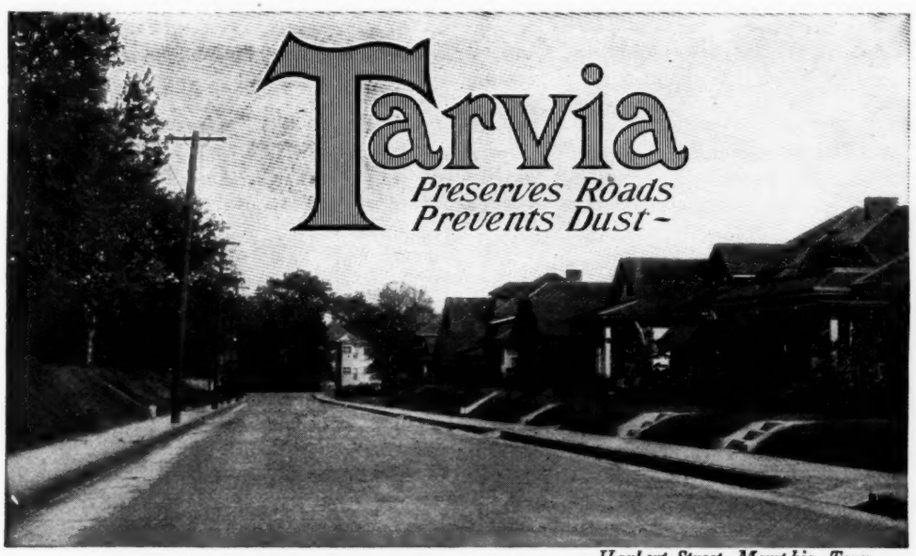
A booklet of extraordinary interest in connection with concrete construction on the farm is now available for gratuitous distribution by the Sandusky Cement Co., of Cleveland, O. It is entitled "Waterproofing on the Farm," and shows the advisability of many farm structures and the high qualities of Medusa waterproofing for such uses. The horse barn, milk house, ice house, dairy barn floor, silo, corn crib, feeding floor, hog house, water trough, hog bath, hog trough, root cellar, duck pond, etc., and the methods of using Medusa waterproofing are illustrated and described.

Dynamite Does Difficult Ditching

The Southern Drainage & Construction Company, of Kinston, N. C., are engineers and contractors engaged in the development of swamp and overflowed land.

In a drainage proposition near Wilmington, N. C., recently, they required a ditch approximately 12 feet wide at the top, 5 feet deep, and 1,200 feet long. The soil was a heavy, wet muck, covered with a tangle of underbrush and stumps.

President Hodges, of the company, reads the engineering



Harbert Street, Memphis, Tenn.
Constructed with "Tarvia-X", 1911
Treated with "Tarvia-B", 1914

Over 50 Miles of Tarvia in Memphis—

LIKE many other towns Memphis uses Tarvia right along year after year as a fixed policy because tarviated macadam is the most economical roadway for modern traffic.

Memphis began in 1910 with modest experimental stretches of Tarvia work. These proved so satisfactory that larger contracts were made in succeeding years.

The Memphis conditions illustrates the versatility of Tarvia, for Memphis has used Tarvia on many kinds of roadways—gravel, macadam and concrete.

There are three grades of Tarvia and a dozen ways of using them. The processes for treating old roads are somewhat different from building new ones. Climate and traffic have a bearing on the question.

We don't attempt to make one material and one process serve for all kinds and varieties of road conditions. There is a Tarvia process for most road problems.

Write our Service Department for illustrated booklet and further information.

Special Service Department

This Company has a corps of trained engineers and chemists who have given years of study to modern road problems.
The advice of these men may be had for the asking by anyone interested.
If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The Barrett Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
Detroit Birmingham Kansas City Minneapolis Salt Lake City Nashville Seattle Peoria
THE PATERSON MANUFACTURING CO., Limited: Montreal Toronto Winnipeg
Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

TRADE B MARK

papers and keeps posted on new machinery, new methods and new ideas generally applicable to his contracting business. He had read that ditches could be blasted with dynamite under the conditions that confronted him.

As he had no men in his employ that had had experience in ditching with dynamite, he told his troubles to a professional blaster. The result was a ditch almost as uniform as one dug in the usual way and with much less expenditure of time and trouble.

Professional blasters should seek the acquaintance of every contractor in their localities. Many a good blasting job can be had from contractors if they are kept posted as to what work blasters can be of help to them.

A Double Contractor's Pump

One of the convenient combinations of the Atlantic gasoline pumping engine, made by Harold L. Bond Co., 383-391 Atlantic avenue, Boston, Mass., is one which mounts on one end of the truck carrying the engine a diaphragm pump and on the other end a centrifugal pump.

The engine is of 3½ h.p., with speed of 350 to 550 revolutions a minute, 5-inch bore, 6-inch stroke, with two spark plugs, one connected to Sumter magneto and one to a set of dry batteries.

The pumping engine is connected by back gear to a No. 4 diaphragm pump of 2,500 to 8,000 gallons an hour, depending on speed, height and directness of suction lift.

The centrifugal pump has 3-inch suction, 2½-inch discharge and capacity of 12,000 gallons an hour. It is driven by belt from the engine over a spring tension idler coupled up for 30-foot duty at maximimum speed.

The centrifugal pump may be used in the morning to get rid of excess water quickly atnd operation continued with the diaphragm pump. However, the engine is powerful enough to operate both pumps at the same time at a combined rate of 300 gallons a minute on most jobs.

The Motor Lawn Mower a Decided Advance

The chairman of the green committee of the Sudbrook Park Golf Club, Sudbrook Park, Md., says that they have used an auto mower for two seasons and it has done remarkably good work. It is decidedly faster than a horse motor, cheaper to operate, and has made a decided improvement in their golf course, having rolled it down to a good even turf without any of the cuts which a horse machine makes. They consider the machine indispensable. It was made by the Coldwell Lawn Mower Co., Newburg, N. Y.

Trade Notes

There is some prospect for the sale of concrete mixers in Barcelona, Spain, tho but three contractors in that city use them. The mixer should be sold separately for use with local power apparatus, mostly electric, according to Consul General Hurst.

A new by-product of cement plants is potash salts. When the Riverside Portland Cement Co. were obliged to abate their dust nuisance in the orange region of California some three years since, they found that a commercial amount of low-grade potash salts could be separated from the dust. Their experience is the basis for the installation of similar outfits by the Security Cement and Lime Co., Hagerstown, Md., and the new Universal Portland Cement plant at Duluth, Minn., now under construction.

The price list recently promulgated by all the photo-engravers of the country has been abandoned by the Photo-Engravers' Board of Trade of New York City, as a result of correspondence with District Attorney Swann, of New York county, concerning the proposal of the district attorney to determine by proper court proceedings whether the "standard scale of prices" of the association was not a violation of the Donnelly anti-trust law of the state of New York.

The Barrett Mfg. Co. now offers surety company's guaranty of roofs laid according to The Barrett Specification for twenty years under reasonable requirements as to inspection of contractors' work by the company's inspectors and acceptability of contractor.

The labor situation is the subject of an investigation made by O. R. Rietschlin, the head of the employment department of the Aberthaw Construction Co., Boston, Mass. The report goes into considerable detail and the result, in brief, shows that as compared with normal times New England has a shortage of 47,000 and New York of 110,000 South Italian laborers and that the increase in immigration from other countries is very insignificant. Consequently, the price for unskilled labor in the East must increase materially and will undoubtedly equal or exceed 30 cents an hour.

The output of creosoted wood paving blocks in 1915 was enough for 2,937,132 square yards of pavement, an increase of 12.3 per cent over that of 1914.

The MacArthur Concrete Pile and Foundation Co. have moved their New York office to the Equitable building, 120 Broadway.

The Standard Brick Company, of Crawfordsville, Ind., has taken out a license from the Dunn Wire-Cut Lug Brick Company for the manufacture of wire-cut lug paving brick. This makes thirty companies operating forty-eight plants now engaged in the manufacture of wire-cut lug brick. The Standard Brick Company is an established concern with a daily capacity of 25,000 brick, but it is enlarging its plant to a capacity of 35,000 brick daily with the necessary additional kilns to handle the output. The plant now has seven kilns of 70,000 capacity each.

The Southern Clay Manufacturing Co., Chattanooga, Tenn., has purchased the Graves paving brick plant at North Birmingham, Ala., and will at once begin making wire-cut lug brick at that plant. The Southern Clay Manufacturing Company already has plants at Robbins, Tenn., and Coaldale, Ala. The demand for this type of brick in the South has necessitated the purchase of the additional plant.

Trade Publications

The Electro-Sanitation Co., Los Angeles, Cal., publishes two pamphlets giving engineers' report on sewage disposal plants at Durant, Okla., and New Brighton, Pa.

The Highway Magazine, issued by the American Rolling Mill Co., Middletown, O., shows the value of Armco corrugated culverts and their use in many situations, including culverts under very high fills.

Bulletin 68 of the Blaw Steel Construction Co., Pittsburg, Pa., describes the design and construction of the highest reinforced concrete water tower tank, which is located at Middleboro, Mass.

The Blaw Steel Construction Co., Pittsburg, Pa., have a handsome booklet, entitled "More Profits in Concrete Culvert Construction," which shows the Blaw adjustable rectangular culvert form and gives specifications for it and prices. It is Blaw service bulletin No. 70.

Sternberg 5 and 7-ton motor trucks are shown in their details and in operation for many uses in a large folder, entitled "A Big Message on Big Trucks," of the Sternberg Motor Truck Co., West Allis, Milwaukee, Wis.

The Russel Grader Mfg. Co., Minneapolis, Minn., issue a 100-page catalog of their elevating grader, ditcher and wagon loaders, grader disc plows, road planer, scarifier, road machines, dump wagons, steel beam bridges, corrugated and built-up culverts, scrapers, etc.

A GROWTH BASED ON SHEER MERIT

NO GUESS WORK **NOTHING BUT QUALITY**

Bitulithic pavement has grown from 16,400 square yards in 1901 to the extent of over 39,000,000 square yards in over 400 cities, which is equivalent to over 2,200 miles of roadway 30 feet wide between curbs.

If **Bitulithic** is once adopted for your streets, you will always insist on it. Additional large contracts are constantly being awarded by the cities that have used it for many years.

BITULITHIC means quality

Bitulithic Pavement—intersection Orange Grove Ave. and Colorado St., Pasadena, Calif.

If your streets are paved with **Bitulithic** the attractiveness of your city to visitors as a place of residence will be increased and indirectly result in a growth of population.

Automobilists constantly travelling over the **Bitulithic** streets carry its praise everywhere.

Is not the experience of over 400 cities enough to satisfy you that **Bitulithic** is the **"Best by every Test"?**

"We could build *cheaper,* but we won't—
We would build *better,* but we can't."

Do not wait until a mistake is made—pave your streets with **Bitulithic** and avoid mistakes.

Bitulithic appeals alike to city officials, property owners and automobile drivers.

Bitulithic is a sanitary, dustless, non-skidding pavement, and affords a secure foothold for horses.

Write today for illustrated booklets and learn more about
this modern, ideal street pavement for modern cities.

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ROCHESTER, N. Y.
LOS ANGELES, CAL.
TORONTO, ONT.
VANCOUVER, B. C.
PORTLAND, ORE.
RICHMOND. VA.
MONTREAL, P. Q.

Lead lined iron pipe is made by the Lead Lined Iron Pipe Co., Wakefield, Mass., who issue a booklet giving many instances of the uses to which it is put by prominent purchasers. They make tin-lined iron pipe also.

The National Concrete Sign and Post Co., Oil City, Pa., send a number of reproductions of photographs of their sign posts, signs and various methods of mounting them on concrete, iron and wood, the process of inbedding the letters in the concrete, building tablets, etc.

The Blackstone process for manufacture of bituminous concrete mixtures for roads and pavements at a central plant is exploited in a pamphlet by J. A. W. Pine, consulting engineer, 15 Broad street, New York.

The Republic Creosoting Co., Indianapolis, Ind., has made a handsome reprint of P. C. Reilly's paper on "The Proper Oil for Treating Creosoted Wood Paving Block," before the American Society of Municipal Improvements, which will be sent to any one interested.

The National Tube Co., Pittsburg, Pa., have a folder descriptive of the motion pictures of the process of making National pipe from ore to finished product.

A booklet of the Semet-Solvay Co., Syracuse, N. Y., is devoted to Solvay granulated calcium chloride, "a national dust layer."

A new book about Medusa waterproofing, issued by the Sandusky Portland Cement Co., Cleveland, O., shows the many uses to which the Medusa waterproofing paste and powder are put in concrete construction, in reservoirs, tunnel linings, pump pits, shelters, farm buildings, concrete blocks, burial vaults, bathing pools, buildings, etc.

"Shale Bed to Road Bed, the story of the best paving brick made," is the title of a very handsome booklet containing "a story of the making of Metropolitan paving brick," by the Metropolitan Paving Brick Co., Canton, O.

Pioneer Expansion Joint Compounds are described in a circular of The Pioneer Asphalt Co., Lawrenceville, Ill., who are producers of the highest quality of bituminous products.

The use of electricity for setting off blasting charges is fully described in numerous articles on the subject in the DuPont Magazine, Wilmington, Del., which will be sent anyone, free, on request.

The first municipal water and light plant in the world to instal Diesel oil engines is at Menasha, Wis. The engines are shown in detail in a circular of the Busch-Sulzer Bros-Diesel Engine Co., St. Louis, Mo.

Oakoal, the product of a process for making fuel of animal droppings, where fuel was scarce, applied to garbage and other city refuse, is shown, as to its practical working, in a booklet of the Co-Coal-Co., Kansas City, Mo.

The Harrison Safety Boiler Works, Philadelphia, Pa., issue a 68-page book on "finding and stopping waste in modern boiler rooms" by the use of Cochrane meters.

Wm. E. Dee Clay Mfg. Co., Mecca, Ind., and Chicago, are distributing a convenient discount price list of the sewer pipe, fire clay flue linings and wall coping which they manufacture.

The Association of Creosoting Companies of the Pacific Coast. Seattle, Wash., has published, in pamphlet form, a valuable paper by O. P. M. Goss, consulting engineer, on "Creosoting Douglas Fir Bridge Stringers and Ties Without Loss in Strength."

Bulletin No. 46023, recently issued by the General Electric Company, describes briefly that company's arc circuit volt meter, which is a special instrument designed for testing direct current series arc circuits. The approximate dimensions and the connections, together with prices, are included.

The Spaulding system of interchangeable metal forms for reinforced concrete construction, patented in 1916, is described in a booklet issued by the Pyramid Fireproofing Company, 52 Vanderbilt avenue, New York.

The Precision Computer

A new calculator for engineers which gives an accuracy 100 times as great as the slide-rule has been recently devised and placed on the market. Tho but 8 inches in diameter its accuracy is equivalent to that of a slide-sule 100 feet long; it combines the accuracy of 5-place, interpolated logarithms with the speed and convenience of a slide-rule, without the drawbacks of either. It solves expressions like $(879.65+74.769) \times 72.638=854.58$—with an ultimate accuracy of 1/1000 of 1%, or 1 in 100,000.

The length of scale is 120 times as great as that of the A and B scales in the ordinary 10-inch slide-rule; the system of graduations is uniform thruout, and reads 5 figures thruout, like 24364, 67342, 99893, etc.; the variable graduations of the slide-rule have been eliminated in this computor. Most engineering data has an accuracy of from 3 to 5 figures, and calculations have therefore been carried out heretofore by logarithms to 5 places. The Precision Computer has been devised to do this work automatically.

The Ross Precision Computer consists of a graduated dial rotating under a slotter cover, a floating guide, and a slide mounted at the right of the slot. The operation of the dial gives results to an accuracy of 5 significant figures throughout. The slide carries a miniature of the dial scale, and may be used alone to obtain an accuracy of 3 figures; it co-operates with the dial to check and point out the precise answer, and to locate its decimal point.

To multiply and divide any series of numbers it is only necessary to set each number in succession under the reading line in the slot; the answer is then read, also under the slot-line. The manipulations for setting the given numbers on the dial are extremely simple; succint directions are given on the face of the computer.

The use of the instrument requires no knowledge of mathematics or logarithms—it reads as simply as a foot-rule or watch-dial; but if desired the computer may be used to read 5-place logarithms and anti-logarthms of all numbers directly, much faster than from logarithmic tables, and obviating besides, fingering pages of tables, mental interpolations, and errors. Powers, roots and other complex operations may be carried out either approximately, or to a high degree of precision, as desired. Trigonometric calculations made by the Precision Computer give an accuracy of from 3 to 5 seconds of arc.

The Precision Computer is made of metal thruout; the graduations are engraved on silvered metal surfaces, like a surveyor's compass or transit. The instrument is packed securely in a flexible case, and forms a permanent, portable and inexpensive precision computer. It has been invented by Louis Ross, civil engineer, San Francisco; and is manufactured by the Computer Mfg. Co., 25 California street, San Francisco.